Three Essays on Applied Microeconomics

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

Yoon Sun Hur

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

PAUL GLEWWE

August 2015

Acknowledgement

I am deeply grateful to my advisor, Paul Glewwe, for the advice and support throughout my doctoral program. His valuable guidance helped me in all the time of study and writing this thesis. I am indebted to my thesis committee, Marc Bellemare, Morris Kleiner, Glenn Pederson, and Aaron Sojourner, for their comments, feedbacks, and encouragement. Outside of the university, Samuel Schulhofer-Wohl at the Federal Reserve Bank of Minneapolis has been important advisor for me, providing valuable inputs and guidance throughout the entire process.

I thank my fellow classmates for surviving from coursework together, for the discussions we made during the class, and for the fun we have had in the last five years. My friends, especially Ana Cuesta, Milda Irhamni, and Jooyoung Yang, made my graduate school life more pleasant and abundant.

Last but not the least, I would like to recognize the support of my family. I deeply thank my husband, Heeman, for his help and support to pursue my degree. My daughter, Celine, has been a perfect energizer for me when I was writing this thesis. I am also grateful to my parents, Sunhee Park and Young-Il Hur, my siblings, and parents in-laws for their spiritual support throughout the program and my entire life. Finally, thanks God for being always with me.

Dedication

To my husband, Heeman, and my daughter, Celine.

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Chapter 1

Introduction

When and how does a child's human capital, including both cognitive and non-cognitive skills, develop? Scholars have noted that the early stage of life (i.e., the first five years) is crucial for the accumulation of human capital (Santrock, 1998; Grantham-McGregor et al., 2007). Cunha and Heckman (2007) propose that there are two characteristics of human capital accumulation: complementarity and self-productivity, which implies that investment in education should start at the first stages of childhood. Many empirical studies also provide evidence that early intervention, when a child is a preschooler, has a high rate of return (Currie and Thomas, 2000; Campbell et al., 2008; Heckman et al., 2010; Reynolds et al., 2011).

During childhood, especially in the pre-school years, parents' investment is one of the most important determinants of child human capital accumulation. A large literature has revealed that family income, background, school quality etc., all have significant effects on child human capital. Becker and Tomes (1986) and Lochner and Monge-Naranjo (2011) indicate that liquidity constraints, defined as the inability to raise money for investment or consumption smoothing purpose, have a negative effect on parents' investment in their child's human capital.

In the context of developing countries, the link between a child's human capital and liquidity constraints may be potentially strong. Human capital accumulation is both a method of obtaining development and a goal for developing countries. Ever since Schultz (1963) introduced the importance of education in economics, scholars have discussed the relationship between human capital and economic development. Lucas (1988) and Mankiw, Romer, and Weil (1992) developed theoretical models that emphasize the role of human capital accumulation in economic growth. Barro (1991) empirically demonstrated that initial school enrollment, a proxy for human capital, was positively related to the growth rate of real GDP per capita between 1969 and 1985. Hanushek and Woessmann (2008) used international data on mathematics and science test scores as measures of human capital to demonstrate a positive relationship between cognitive skills and growth from 1960 to 1990. Glewwe and Jacoby (2004) indicates that education is the primary route for developing countries to escape from poverty.

Because there is wide agreement about the positive relationship between education and growth, policymakers have established education as one of the top priorities in their development agenda. For example, the United Nations' Millennium Development Goals have named education as two out of eight development goals, and many developing countries have set universal primary and secondary education as one of their development goals. Vietnam, for example, has formally developed a "Socio-economic development strategy for the period of 2011–2020" that includes the enhancement of the quality of primary and secondary education, and also universalization of pre-school education.

Financial development is another key engine of growth (Bencivenga and Smith, 1991; Greenwood and Smith, 1997; Hassan, Sanchez, and Yu, 2011). Unfortunately, developing countries are often behind in this area. The "Global Financial Development Report 2014" of the World Bank (2014a) provides indices to measure the extent of financial development for each country. The percent of private credit, which is calculated by dividing the amount of financial deposits in banks by gross domestic product (GDP), is 53 percent worldwide, 107 percent for developed economies, and 34 percent for developing countries. Accessibility to financial institutions is lower for developing economies: the percentage of people who have an account at a formal financial institution in developing economies is 30 percent, compared to 87 percent in developed economies. Hence, financial development may be crucial in determining the liquidity constraint status for households in developing countries.

The link between liquidity constraint and human capital accumulation has been an attractive topic for scholars (e.g. Becker and Tomes (1986) and Jacoby and Skoufias (1997)). However, few things are known about the effect of liquidity constraints on human capital development for young children of pre-school age. Also, most studies of developing countries have measured human capital in terms of schooling, and measured the effect of liquidity constraints on child's schooling. Few things are revealed on the effect of liquidity constraints on a child's cognitive and non-cognitive skills in the context of developing countries.

My first and third essays contribute to the literature on the link between parents' liquidity constraints and children's human capital accumulation, measured by cognitive and non-cognitive skills. The first essay, entitled "Effect of liquidity constraints on school learning in Vietnam," attempts to determine whether the liquidity constraints of parents and the timing of such constraints matter in the development of children's cognitive skills. The third essay, "Effect of liquidity constraints on children's non-cognitive skills in Vietnam," measures the effect of parents' liquidity constraints on childrens non-cognitive skills, such as self-esteem, self-efficacy, and aspirations.

The second essay deals with a different issue: the effect of licensing on the engineers' labor market. Occupational licensing has been growing in the U.S. labor market over the last decades. For the engineers, the regulation began in 1990 and now all 50 states require licensure for the practice of civil engineers. The license status of engineers varies by the type of engineer: civil engineers are most regulated while industrial engineers are the less regulated. This essay presents theoretical and empirical analysis about the licensing status of engineers on their labor market by the type of engineers.

This dissertation is organized as follows. Chapter 2 estimates the effect of parents' liquidity constraints on children's school achievement in Vietnam. Chapter 3 shows the theoretical and empirical analysis on the effect of liquidity constraints on engineer's labor market in U.S. Chapter 4 presents the empirical analysis on the effect of parents' liquidity constraints on children's non-cognitive skills. Chapter 5 concludes.

Chapter 2

Effect of Liquidity Constraints on School Learning in Vietnam

2.1 Introduction

Liquidity constraints have been considered one of the most important factors that determine human capital accumulation (Becker, 1975; Flug, Spilimbergo, and Wachtenheim, 1998). Parents' decisions about their children's human capital accumulation depend on the liquidity constraints faced by the parents. A household's income may be vulnerable to many types of shocks, such as extreme weather, disasters, and parents' layoffs. If households cannot insure their incomes against these shocks, they attempt to use other methods to smooth their consumption in response to these shocks. In some cases, the investments in a child's human capital accumulation may decrease in order to smooth consumption. However, if households are not liquidity constrained and so can borrow from various sources (e.g., formal and informal loans, loans from relatives, etc.), both their children's human capital accumulation and the households' overall consumption might not be affected by income shocks (Becker and Tomes, 1986; Jacoby and Skoufias, 1997).

The timing of liquidity constraints is another important determinant of children's human capital accumulation. Cunha and Heckman (2007, 2010) presented evidence that human capital begins to develop at an early age. Self-productivity in human capital formulation implies that early stocks of human capital determine later stocks of human capital.[1] This implies that parents' investments during early childhood are important for developing a child's stock of human capital.

The link between liquidity constraints and educational investment has attracted the attention of many scholars. Keane and Wolpin (2001) and Belley and Lochner (2007) measured the relationship between liquidity constraints and post-secondary schooling decisions in the United States, and found negative effects of liquidity constraints. However, some of those papers argue that the liquidity constraints' effect on school enrollment disappears when one controls for the ability and parental background (Carneiro and Heckman, 2002). Only a few studies have measured the effect of liquidity constraints on school attendance in the context of developing countries. Jacoby and Skoufias (1997) found that income shocks negatively affect children's school attendances in India. Devicienti and Rossi (2013) found that the income uncertainty combined with binding liquidity constraints has a negative effect on the children's schooling in Tanzania.

There are two challenges when estimating the causal effect of liquidity constraints on children's educational outcome. First, most studies measure liquidity constraints only indirectly when investigating the effect of income shocks or external subsidies on human capital investment (e.g., Keane and Wolpin (2001), Jacoby and Skoufias (1997) and Carneiro and Heckman (2002)). Indirect methods detect liquidity constraints by looking for violations of the life-cycle/permanent income hypothesis (LC/PIH). The theoretical reasoning underlying this approach is that "in the absence of liquidity and borrowing constraints, transitory

[1] Following Cunha and Heckman (2010), self productivity of human capital investment occurs when a person's skill in one stage of his or her life cycle is affected by his or her skill at previous stages of the life cycle. This explains why investments in later stages of the life cycle are important to maintain and increase the effect of earlier investments. The effect of an earlier investment may be reduced if the investments in later stages are not sufficient. These two characteristics indicate that investments during the early stages of a life cycle have a significant role in human capital investment.

income shocks should not affect consumption" (p. 4, Diagne, Zeller, and Sharma (2000)). The studies that use this indirect method estimate whether transitory income or income shocks have a significant effect on economic behavior, such as savings (Rosenzweig and Wolpin, 1993; Browning and Lusardi, 1996), entrepreneurial choice (Evans and Jovanovic, 1989), and investment in education (Jacoby and Skoufias, 1997; Calero, Bedi, and Sparrow, 2009).

However, the indirect measures of the effect of constraints and the different assumptions needed to use them may lead to mixed estimates of the effect of constraints (Stinebrickner and Stinebrickner, 2008). Few studies try to directly measure liquidity constraints by employing direct questions from surveys. Jappelli, Pischke, and Souleles (1998) defined a household as being liquidity constrained when its credit request is turned down and/or it does not have any credit cards.[2] Feder et al. (1990) asked whether the farmers who borrowed money want to obtain more money than they actually borrowed and defined a farmer as liquidity constrained when a farmer answers, "Yes, I want to obtain more money." However, few things are known about the direct measure of liquidity constraints and its effect on education in developing countries context.[3] Following the literature that uses direct measurement, this chapter measures liquidity constraints directly using a specific question from the Young Lives household questionnaires for Vietnam, as discussed in more detail below.

The second challenge is potential bias due to the endogeneity of liquidity constraints. Liquidity constraints may be endogenous due to the correlation between liquidity constraints variable and error terms, such as parent's ambition. Also, liquidity constraints may be endogenous due to various factors such as individual characteristics, government policies,

[2] Jappelli, Pischke, and Souleles (1998) divided their liquidity constrained sample into three categories: households who have experienced being turned down for a credit request; households without any credit card or line of credit; and households who have been turned down for credit and have no credit card at the same time.

[3] Devicienti and Rossi (2013) used the amount of durable goods and savings as proxies for liquidity constraints. To see the effect of liquidity constraints when there is income uncertainty, they estimate the effect of an interaction term between a dummy variable for durable goods (or savings) and variance in crop loss. But Devicienti and Rossi (2013) do not directly measure the liquidity constraints of households.

and weather conditions (Lochner and Monge-Naranjo, 2002; Fitzsimons, 2007). To correct for bias due to endogeneity, this chapter uses an instrumental variable (IV) approach, using the following instruments for liquidity constraints: a dummy for the existence of close relatives in the community; a dummy for the existence of subsidized credit programs in the community; a dummy for savings cooperatives in the community; the interaction between past rainfall volatility and father's occupation; and the interaction between a current rainfall shock and father's occupation. These instrumental variables exploit information on the financial environment of households and are not expected to have a direct effect on a child's human capital accumulation.

To examine the importance of timing in investment in children's human capital, this chapter estimates the effect of liquidity constraints at various stages of childhood on a child's human capital accumulation. The Young Lives data for Vietnam used in this chapter were collected from 3,000 children (2,000 younger cohort children and 1,000 older cohort children) over three rounds. Round 1 took place in 2002 (younger cohort children were 0–1 year old, while older cohort children were 7–8 years old), Round 2 was in 2006 (younger cohort children were 4–5 years old, while older cohort children were 11–12 years old), and Round 3 in 2009 (younger cohort children were 7–8 years old, while older cohort children were 14–15 years old). Using these data, this chapter first estimates the effect of current liquidity constraints on children's educational outcomes. To see whether the timing of investment matters, the estimation is conducted using two rounds of surveys for two cohorts.[4] In addition, the longitudinal data enable one to investigate the effect of liquidity constraints in the early stages of childhood, which are thought to be critical for a child's human capital accumulation. By estimating the effect of liquidity constraints in early childhood on cognitive skills as measured by test scores at a later age, this chapter searches for evidence of the effect of liquidity constraints in early childhood on human capital accumulation.

This chapter makes several contributions to the literature. First, it presents estimates

[4]The liquidity constraints variable is not measured in Round 1. So the analysis includes only Round 2 and Round 3

for a developing country based on direct measures of liquidity constraints. Second, it considers the potential bias caused by endogenous liquidity constraints, and uses instrumental variables to reduce the bias. Finally, this chapter measures the effect of early liquidity constraints on later child human capital accumulation as well as the effect of current liquidity constraints on human capital accumulation.

This chapter proceeds as follows. Section 2.2 provides an overview of the educational system in Vietnam. Section 2.3 develops a theoretical framework that relates liquidity constraints to children's educational outcomes. Section 2.4 describes the Young Lives household questionnaires for Vietnam and the rainfall data. Section 2.5 develops the empirical specification. The estimation results are presented in Section 2.6. Finally, Section 2.7 summarizes the results and suggests policy implications.

2.2 Background of the Educational System in Vietnam

The formal school system in Vietnam consists of five years in primary school, four years in lower secondary school, and three years in high school. Children can enroll in pre-primary schools before they are school-aged, but pre-primary education is not compulsory. Primary education from the age of 6 to the age of 11 (grade 1 to grade 5) has been compulsory for all children in Vietnam ever since the 'Law on Universal Primary Education' was adopted in 1991, and so the primary education enrollment rate has increased to 100 percent in the past two decades. The net primary school enrollment rate in Vietnam was 99 percent and the primary completion rate was 100 percent in 2012 (World Bank, 2014b). Also, secondary school enrollment and the secondary completion rate have dramatically increased since 1992. In 2008–2012, the secondary school enrollment rate in Vietnam reached 78 percent for males and 84 percent for females, which are almost threefold increases compared to figures from 1992 (UNICEF, 2014).

The Vietnamese government has increased financial support for education over the past decades. The share of education in the national budget increased from 7 percent to 20 percent between 1986 and 2008 (World Bank, 2011). Public spending on education was 6.3 percent of Vietnam's gross domestic product (GDP) in 2010. That share is almost twice the average share of spending on education in other Southeast Asian countries (World Bank, 2014b). The main goals of the Vietnamese government's education policies are to expand school resources and to enhance the quality of education. These policies have been successful, and both the quality and the quantity of education in Vietnam have increased in recent decades.

However, it is still the case that students from disadvantaged backgrounds have lower school achievement than students from advantaged backgrounds (e.g. Rolleston et al. (2013) and World Bank (2011)). Concern is particulary high for the ethnic minority children in the lowest income quintile who live in the rural areas. A second concern is the lack of time for formal learning in primary schools. Even though the number of full-day primary schools (FDS, at least 30 periods per week) has increased in the past few years, Vietnam has one of the lowest hours of formal instruction among all developing countries (Rolleston et al., 2013). In the Young Lives school survey for Vietnam, only 51 percent of head-teachers in primary schools answered that their school offers FDS. Thus many students in Vietnam spend only half a day or less in school. FDS can be helpful in enhancing the efficiency of learning, especially for disadvantaged students.

2.3 Theoretical Framework

2.3.1 Parental Decisions on Child Investment

Caucutt and Lochner (2012) formulated a model to estimate the effect of the timing of liquidity constraints on human capital investment. The dynamic model, and their empirical analysis using the Children of the National Longitudinal Survey of Youth, suggest that a dynamic complementarity exists between early and late investments, and that early investment plays a significant role in human capital accumulation. This chapter employs the optimal life cycle investment model from Caucutt and Lochner (2012) for its theoretical framework.

Suppose that there are three time periods. The childhood of an individual with an initial ability to learn denoted by θ can be divided into early childhood (first period) and late childhood (second period). Parents make decisions about consumption for all three periods (c_1, c_2 and c_3) and investments in child education for the first two periods (i_1 and i_2). The child's adult stock of skills in the third period, h_3, is a function of child initial ability to learn (θ) and early and late childhood investments (i_1 and i_2).

$$h_3 = f(i_1, i_2, \theta) \tag{2.1}$$

The human capital production function in equation (2.1) is assumed to be concave and increasing in i_1 and i_2. Assume also that ability and investment are complements, in other words that $f_{13} \geq 0$ and $f_{23} \geq 0$.

The household's utility depends on its consumption in all three periods (c_1, c_2, and c_3). Consumption after the first period is discounted at the rate of β. The main source of income for the household when the child is in the school is parent's income (y) and loans (a, where $a < 0$). After the child grows up, the child contributes to household income through his or her labor $w(h_3)$. Parents' assets at the end of period t earn a gross return rate R, so that assets at the beginning of period $t + 1$ equal Ra_t. Parents can also borrow at the same interest rate R, but there is a limit on the amount of debt that can carried over to the next period (L_t).

The decision problem can be separated into two parts: during the childhood (period 1 and 2) where the investment occurs, and after the investment (period 3).

After childhood, the household earns income from the child with human capital h_3 and assets a_3. The parents care only about consumption in this period,[5] so they maximize their utility as: $V_3(a_3, h_3) = \max_{c_3} u(c_3)$. The budget constraints for period 3 is $a_4 = Ra_3 + w(h_3) - c_3$. Since the asset in the fourth period is assumed to be zero ($a_4 = 0$), the budget constraints can be rewritten as $Ra_3 + w(h_3) = c_3$.

During childhood that is period 1 and 2, the problem for parents is:

$$U = \max_{c_1, c_2, i_1, i_2, a_3} u(c_1) + \beta u(c_2) + \beta^2 V_3(a_3, f(i_1, i_2, \theta)) \tag{2.2}$$

subject to the budget constraints:

$$a_{t+1} = Ra_t + y_t - i_t - c_t, \text{ for } t = 1,\ 2, \tag{2.3}$$

and the borrowing constraints:

$$a_{t+1} \geq -L_t, \text{ for } t = 1,\ 2, \tag{2.4}$$

Solving the first order conditions for consumption yields:

$$u'(c_1) \geq \beta R u'(c_2) \tag{2.5}$$

where the inequality is strict if and only if the borrowing constraints bind.

[5]The parents spend all money on consumption and paying back previous loans.

Solving the first order conditions for investment and assuming interior solution simplifies that:

$$\begin{aligned} u'(c_1) &= \beta^2 \frac{\partial V_3(a_3, h_3)}{\partial h_3} f_1(i_1, i_2, \theta) \\ u'(c_2) &= \beta \frac{\partial V_3(a_3, h_3)}{\partial h_3} f_2(i_1, i_2, \theta) \end{aligned} \tag{2.6}$$

where $\frac{\partial V_3(a_3,h_3)}{\partial h_3} = wu'(c_3) > 0$. The first order conditions indicate that the marginal rate of substitution for consumption equals the technical rate of substitution in the production of human capital:

$$\frac{f_1(i_1, i_2, \theta)}{f_2(i_1, i_2, \theta)} = \frac{u'(c_1)}{\beta u'(c_2)} \geq R \tag{2.7}$$

2.3.2 Effect of Liquidity Constraints on Child Investment

Solving the first of conditions for assets yields:

$$u'(c_1) \geq \beta R u'(c_2) \geq (\beta R)^2 u'(c_3) \tag{2.8}$$

Combining the first equations in (2.6), (2.7) and (2.8), we have:

$$u'(c_1) \leq \beta^2 w f_1 (\frac{u'(c_1)}{(\beta R)^2}) = u'(c_1) w f_1 \frac{1}{R^2} \tag{2.9}$$

Equation (2.9) shows that $f_1 \geq \frac{R^2}{w}$, where the inequality is strict if any borrowing constraints bind. With similar algebra, combining the second equation in (2.6), (2.7) and (2.8), we have $f_2 \geq \frac{R}{w}$ where the inequality is strict if any of borrowing constraints L_2 binds.

Denote unconstrained optimal investments for human capital, given ability θ, by $i_1^u(\theta)$ and $i_2^u(\theta)$. From equation $f_1 \geq \frac{R^2}{w}$ and $f_2 \geq \frac{R}{w}$, those investments satisfy:

$$
\begin{aligned}
f_1(i_1^u(\theta), i_2^u(\theta), \theta) &= \frac{R^2}{w} \\
f_2(i_1^u(\theta), i_2^u(\theta), \theta) &= \frac{R}{w}
\end{aligned}
\tag{2.10}
$$

Equations in (2.10) indicate that the investment in child human capital is not affected by income in the unconstrained case.

The following equations are derived from equation (2.8), (2.9) and (2.10):

$$
\begin{aligned}
f_1(i_1^*(\theta), i_2^*(\theta), \theta) > f_1(i_1^u(\theta), i_2^u(\theta), \theta) &= \frac{R^2}{w} \\
&\text{, iff any borrowing constraints bind.} \\
f_2(i_1^*(\theta), i_2^*(\theta), \theta) > f_2(i_1^u(\theta), i_2^u(\theta), \theta) &= \frac{R}{w} \\
&\text{, if the second period borrowing constraints binds.}
\end{aligned}
\tag{2.11}
$$

The equations in (2.11) demonstrate that when there is a binding borrowing constraint during early childhood (first time period), there is under-investment during the period ($i_1^* \leq i_1^u$). Also, when there is a borrowing constraint during the late childhood period (second time period), both early and late investment will be less than the unconstrained investment ($i_1^* \leq i_1^u$ and $i_2^* \leq i_2^u$).[6]

[6] Caucutt and Lochner (2012) provide the proof of this proposition in more detail. See Annex B in Caucutt and Lochner (2012)

2.4 Data

2.4.1 Young Lives Household Survey Data for Vietnam

The Young Lives data for Vietnam are from a survey of 3,000 children, their households, and their communities in Vietnam.[7] The survey collects data on child health, daily activity, his/her likes and dislikes, and school outcomes including test scores in language comprehension and math. Household level data include information about parent's education, household composition, livelihood, savings, consumption, and access to several basic services. The community level data include total population, infrastructure and services, political representation, and community networks.

The survey collects data from two cohorts of children: 1,000 children born in 1994–95 (older cohort) and 2,000 children born in 2001–02 (younger cohort). Three rounds of data have been collected thus far. Round 1 was carried out in 2002, when the younger cohort of children were 6 to 19 months old and the older cohort of children were 7 to 8 years old. Round 2 was implemented in 2006, when the younger cohort of children were 4 to 5 years old and the older cohort of children were 11 to 12 years old. Round 3 took place in 2009, when the younger cohort of children were 7 to 8 years old and the older cohort of children were 14 to 15 years old. Round 4 is was implemented in 2013 (but the data are not yet publicly available) and Round 5 is planned for 2016.

Measurement of Liquidity Constraints

This chapter employs direct measures of liquidity constraints. Liquidity constraints can be defined as a situation where a person wants to borrow a certain amount of money

[7] The Young Lives data cover 12,000 children across four countries: Vietnam, Peru, India and Ethiopia (www.younglives.org.uk). This chapter focuses on the Vietnam data. Young Lives is funded by the UK Department for International Development (DFID) and was co-funded from 2014 to 2015 by Irish Aid. The views expressed here are those of the author. They are not necessarily those of Young Lives, the University of Oxford, DFID or other funders.

but cannot borrow that amount from any sources (Stinebrickner and Stinebrickner, 2008; Jappelli, 1990).[8] The Young Lives household questionnaires for Vietnam include a question on each household's liquidity constraints. This chapter classifies a household as not liquidity constrained if it answers "Yes" to following question:

- **Question 1:** Would your household be able to raise 300,000 VND (in Round 3, for Round 2 the figure was 230,000 VND) in one week if you needed it? [9]
- Answers : Yes / Probably / No

Child Achievement

This chapter measures children's human capital accumulation by their test scores. The model in Section 2.3 indicates that children's human capital accumulation can be affected by households' liquidity constraints, which imply that those constraints will also affect children's test scores. Parents invest in their children in various ways, such as providing nutritious foods, books, or tutors. Those investments should lead to higher child test scores.

The Young Lives data include several cognitive test scores:[10] the Peabody Picture Vo-

[8]In contrast to liquidity constraints, a credit constrained household can be defined as a household that cannot borrow a desired amount of cash from formal or informal lenders at a given interest rate. It includes both borrowers who desire more credit than actually granted at the prevailing interest rate and households who are completely unable to borrow (Feder et al., 1990). The cost to obtain a loan, for example the interest rate and any required collateral, is an important and necessary components of the definition of credit constraints. The literature on measuring credit constraints has considered constraints on both the supply of and the demand for credit (Jappelli, 1990; Feder et al., 1990). A supply side credit constraint exists when the lender imposes credit rationing or rejects the borrower's loan application. Most of the literature on credit constraints considers the supply side of credit constraints (e.g. Foltz (2004)). For demand side credit constraints, the borrower wants to borrow only up to a certain amount of money at the prevailing interest rate. The borrower does not want to pay a higher interest rate for more credit, so the credit constraint is self-imposed.

[9]300,000 VND in 2009 was about 16.25 in 2009 USD. 230,000 VND in 2006 is about 14.94 in 2006 USD. Vietnam's GDP per capita in 2009 was 1,232 USD, and 797 USD in 2006. (Econstat.com) A study about the average expenditure for middle school student in 2003 indicates that the school fees cost about 72,000 VND, books cost 65,000 VND, and uniforms cost 53,100 VND. In addition to that, a middle school students spent 65,000 VND for books, 56,800 VND for other school materials, 107,500 VND for extra study, 66,700 for other contributions, and 30,300 for other expenses. The total cost for a middle school student was 454,000 VND per month (London, 2011).

[10]For more details on tests used in Young Lives Study, see Cueto et al. (2009) and Cueto and Leon (2012)

cabulary Test (PPVT), the Cognitive Development Assessment (CDA) and the Mathematics Achievement test scores. In 2006 when Round 2 was implemented, the younger cohort children were 4–5 years old and too young to take the Mathematics Achievement test. So they took the CDA test instead. Thus the dependent variable varies by cohorts and by survey round in this chapter. For the younger cohort the PPVT and CDA scores are used as the dependent variables in Round 2, and the PPVT and Mathematics Achievement test are the dependent variables in Round 3. The PPVT and Mathematics Achievement test are the dependent variables for both rounds for the older cohort.

The PPVT measures a child's level of vocabulary. The test is designed to select a picture that is the correct response to a stimulus word spoken by a presenter (Cueto and Leon, 2012). There are 204 items in total, and each child gets 1 point when he or she selects a correct picture, so one can score from 0 to 204. In the Young Lives sample, the PPVT ranges between 13 to 163 for the older cohort, and from 5 to 132 for the younger cohort in Round 2. In Round 3, the range is between 46 to 201 for the older cohort and from 27 to 180 for the younger cohort.

The format of the Mathematics Achievement test differs by cohort and by round. In Round 2, only the older cohort took the math test. The test consists of 10 items which measure the number sense of child. The child gets 1 points when they write correct answer for a given item. So the math test in Round 2 can take values from 0 to 10, and in the Young Lives sample scores vary between 0 and 9.

In Round 3, both cohorts took the Mathematics Achievement test but the test format was different by cohort. The younger cohort had 30 items in the Mathematics Achievement test: 10 items to measure counting skills and knowledge of numbers etc, and 20 items on basic calculation such as addition, subtraction, multiplication and division. The older cohort were given 30 items in total: 20 items on basic calculations including square roots and 10 items on mathematics problem solving (Cueto and Leon, 2012). The older cohort selected in this chapter have math scores between 0 to 30, and the younger cohort have math scores between 0 to 29, in Round 3.

Instead of the Mathematics Achievement test, the younger cohort took the CDA test in Round 2. The original CDA was developed by the International Evaluation Association (IEA) and has several sub-sections on spatial relations, quantity, and time. The Young Lives survey data administered only the quantity section, which is designed to have the child select pictures that match verbal statement spoken by a presenter. The statements are related to basic concepts on quantity: e.g. few, more, nothing (Cueto and Leon, 2012). There are 15 items in total, and the younger cohort had scores from 0 to 14.

Individual and household characteristics

The Young Lives household questionnaires for Vietnam collected abundant information on child and household characteristics. To measure the causal effect of liquidity constraints on child educational outcomes, the specification in following section includes individual characteristics of the child and household such as the child's sex and age, the mother's education, the father's education, household income, a dummy variable for rural area, household size, and the child's body mass index (BMI).[11]

This chapter excludes children a who did not participate in any of two survey rounds (Round 2 and 3), or who have missing data for variables of individual characteristics or for test scores. Among 3,000 children in the survey, 56 children are dropped since they do not appear at least one round (0 younger cohort and 56 older cohort). 159 children are dropped since they miss community information (24 older cohort and 135 younger cohort). 412 children of the rest do not have at least one of the test scores (325 for younger cohort, 87 for older cohort). Then 49 children in younger cohort and 44 children in older cohort

[11]The children's weight for height/length Z-score is used more often then the BMI score. However, the Young Lives data for Vietnam have many missing data in the weight for height/length Z-score. The analysis using the weight for height/length instead of BMI score shows similar evidences but with smaller sample size. The author decided to use BMI score instead of the weight for height/length Z-score to have larger sample size in the analysis.

are dropped because of missing data in Rounds 2 and 3. So the total number of sampled children is 1,456 for the younger cohort and 812 for the older cohort.

The summary statistics for the key variables separately by liquidity constraint status, are reported in Table 2.1. The first and second columns show the means and standard deviations of these variables for all children in the sample. The next two columns report the means and standard deviations of variables for children from non-liquidity constrained households, that is those who answered “Yes, I can raise 300,000 VND (in Round 3, for Round 2 the figure was 230,000 VND) if I need it” to the question 1 in Section 2.4. Means and standard deviations of variables for children from households who answer that they can “probably” can raise money, and those from children from households who said that they “cannot” raise money are reported in the following columns.

For both cohorts and both rounds, the test scores of children from non-liquidity constrained households are higher than those of children from liquidity constrained households. There are also some differences across the sub-samples in other individual characteristics. For example, children from non-liquidity constrained household has more educated fathers and mothers and higher household incomes.

2.4.2 Rainfall Data

The rainfall data used in this chapter are from Thomas et al. (2010). The original rainfall data are from Vietnam's Hydro-meterological Data Center, which collects daily precipitation from 172 weather stations in Vietnam. Thomas et al. (2010) provided clean rainfall data between 1976 and 2006 on the World Bank website.[12] The rainfall data for 2007–2009 are from Global Climate Resource Page at University of Delaware.[13] Using the longitudes and

[12]The data can be downloaded at the following link: `http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:22820840~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html$`

[13]The data can be downloaded at : `http://climate.geog.udel.edu/~climate/`

latitudes of weather stations, and those of the sample villages in the Young Lives survey for Vietnam, this chapter matches the nearest weather station to each village. The matched weather stations are all within 50 km of the sample villages.

This chapter calculates past rainfall volatility between 1979 and 1993 to instrument current liquidity constraints. The original data cover rainfall from 1976, but there are many missing values in the rainfall data from 1976 to 1978. Past rainfall volatility should have no direct effect on children's current human capital accumulation. The sample children in the Young Lives data for Vietnam were born in the years 1994 to 1995 (older cohort children) and 2001 to 2002 (younger cohort children). Fitzsimons (2007) indicated that rainfall before children are born does not have a direct effect on households' investment decisions on children's human capital accumulation.[14] So this chapter uses rainfall data between 1979 and 1993 to calculate past rainfall volatility. Rainfall between 1979 and 1993 should not have direct impact on the sample children's human capital accumulation since the oldest child in the Young Lives household questionnaires for Vietnam was born in 1994.

This chapter calculates past rainfall volatility following Fitzsimons (2007). Rainfall volatility can be measured in the ways by variation within the season and the variation between seasons. This chapter divides the daily records of precipitation into two periods, wet season and dry season, for each year between 1979 and 1993. Vietnam is a "bamboo pole" shaped country that is long and narrow from the north to the south. The country exhibits regional differences in weather: the wet and dry seasons differ by region. Vietnam has eight regions: Northwest, Northeast, Red River Delta, North Central Coast, South Central Coast, Central Highlands, Southeast, and Mekong River Delta. Among the 34 villages in the Young Lives household survey for Vietnam, seven are located in the Northeast, seven are in the Mekong River Delta, and seven are in the Red River Delta region. The remaining 13 are located in the South Central Coast region. The Northeast, the Mekong River Delta, and the Red River Delta regions have the wet season from May through October and the

[14] For more identification assumptions of using past rainfall volatility as instrumental variable, please see Section 2.5.

dry season starting in November and ending in April. The South Central Coast region has wet and dry seasons that are different from those in other regions: its wet season is from October to December and the dry season is from January to September. This chapter calculates (a) the coefficient of variation of rainfall over time for each village, and in each of the two seasons; and (b) the ratio of average rainfall during the wet season to that during the dry season. The first instrumental variable captures the variation in rainfall in the village within the season, and the second one measures the spread of rainfall between the two seasons, in each village.

Following Fitzsimons (2007), this chapter presents two figures showing the variation and dispersion of rainfall. Figure 2.1 displays the log of the ratio of mean rainfall during the wet season to that during the dry season. It shows that there is a wide dispersion in rainfall across the regions. Figure 2.2 shows the log of standard deviations of rainfall by season. It indicates that the wet season has higher rainfall and more variation in rainfall compared to the dry season.

This chapter uses rainfall shocks as instruments the liquidity constraints. Following the rainfall shocks calculation method of Jacoby and Skoufias (1997), this chapter calculates (a) the deviation of the current season's rainfall from the average, and (b) the square of the deviation of the current season's rainfall from the average. The average rainfall is calculated using precipitation data from 1979 to 2006. Jacoby and Skoufias (1997) indicated that the current rainfall deviation from the average captures the information about the income shocks of the household.[15]

This rainfall volatility and rainfall shocks are interacted with the fathers's occupation. Rainfall may affect liquidity constraints differently by occupation: farmer's liquidity constraints are likely to be more elastic to rainfall than that of business owner in the non-

[15]There are two types of rainfall shocks: positive and negative rainfall shocks. This chapter runs two specification: one with negative rainfall shocks, and another one with both type of shocks. There are no significant difference between two results, so following empirical analysis section reports only the result using negative rainfall shocks.

agricultural sector (Fitzsimons, 2007; Townsend, 1994). Thus, this chapter divides the father's occupation into seven categories: self-employed in the agricultural sector, wage-employed in the agricultural sector, other in the agricultural sector, self-employed in the non-agricultural sector, wage-employed in the non-agricultural sector, other in the non-agricultural sector, and unemployed. The dummy of each category is interacted with rainfall volatility and shocks.

2.5 Methodology

2.5.1 Effect of Liquidity Constraints on Children's Test Scores using Ordinary Least Squares Analysis

This chapter first estimates the effect of current liquidity constraints on children's current stock of human capital, as measured by scores on achievement tests. To do this, the following specification is proposed:

$$y_{i,h,c,t} = \alpha L_{h,c,t} + \sum_{i=1}^{I} \beta_i X_{i,h,c,t} + \tau_c + \varepsilon_{i,h,c,t} \tag{2.12}$$

where $y_{i,h,c,t}$ is the educational outcome (test score) of child i from household h in community c at period t. $L_{h,c,t}$ is liquidity constraints variable and it includes three dummy variables: first one indicates the households answers " Yes" to Question 1 in Section 2.4, second one indicates when the answer is "Probably", and equals three when the answer is "No". The X_i variables are the characteristics of the child and his or her household, such as sex, age, mother's education, father's education, mother's religion, household income, rural or urban residence, household size, and the child's BMI (weight over height squared) when he or she was first surveyed (when the younger cohort was 6 to 19 months old and the older cohort was 7-8 years old). The variable τ_c allows for community-specific fixed effects and $\varepsilon_{i,h,c,t}$ is an error term. The error term includes the unobserved characteristics and preferences that have effect on human capital investment.

The model of human capital accumulation in Section 2.3 suggests that liquidity constraints at a young age may reduce the child's human capital investment in later ages.

To measure the effect of past liquidity constraints on later child achievement, a more general specification can be applied:

$$y_{i,h,c,t} = \alpha L_{h,c,t-1} + \beta L_{h,c,t} + \sum_{i=1}^{I} \gamma_i X_{i,h,c,t-1} + \tau_c + \varepsilon_{i,h,c,t} \tag{2.13}$$

This specification includes early liquidity constraints, $LC_{h,c,t-1}$.[16]

2.5.2 Effect of Liquidity Constraints on Children's Test Scores using Two Stage Least Squares Analysis

OLS estimates of equation (2.12) and (2.13), however, may yield biased estimates since liquidity constraints are unlikely to be randomly assigned. In this case, the liquidity constraint variables in equation (2.12) and (2.13) are likely to be correlated with the error terms in each equation, in which case the OLS estimates will produce inconsistent results (Wooldridge, 2010). In general, the survey data find difficult to observe variables such as risk aversion or parent's preference that may have significant effects on child human capital investment. If risk aversion has a positive effect on child education, and risk aversion and liquidity constraints are positively correlated, the estimated effect of liquidity constraints is upward biased.

To avoid the potential bias from such endogenous variables, social scientists have widely

[16] To avoid the potential problem of correlation between $L_{h,c,t-1}$ and $L_{h,c,t}$, I empirically measured the same specification as equation (2.13) but without $L_{h,c,t}$. The result is presented in the Appendix.

used two stage least squares (Instrumental variables) analysis. This section explains how the two stage least squares analysis is implemented.

This chapter uses a question in Young Lives household questionnaires for Vietnam to measure the liquidity constraints of households. In the sample, 52 percent of households in Round 2 and 41 percent in Round 3 answer that they can raise that amount of money in a week when they face risk.

A question about the source of money followed the liquidity constraints question, if a household answers "Yes, I can raise the money". Among the households who answer in Round 2 that they can raise money in a week, about 39.2 percent answer that they will get the money from relatives or friends in the community, while only 3 percent say they will get it from formal loan and 4 percent answer that they will use savings. In Round 3, the percent of households who answer that the money will come from relatives or friends in community is even higher, 50 percent, while the percent who say that they would obtain a formal loan drops to 1 percent. The households who would use their savings increases to 20.7 percent in Round 3. Only a few households answer that they will raise money from micro finance (0.3 percent in Round 2 and 0.1 percent in Round 3).

The answers to this question on the source of funds indicates that many households are relying on relatives or friends in their local community when they face risk. Also, savings accounts appear to have an increasing role over time as a mechanism to overcome households' liquidity constraints. Even though the percentage of people relying on micro finance and formal loans is low, the existence of a micro finance or credit programs in the community may also affect households' liquidity constraints.[17] This chapter argues that liquidity constraints may be endogenous in the sense that they depend on the existence of relatives, credit programs, and financial institutions such as savings cooperative in the community.

[17]The portion of households who say they will use loans (including both formal and informal loans) or micro finance is slightly higher in community with credit program (10 percent) than that in community without credit program (6 percent).

Other instrumental variables are past rainfall volatility and rainfall shocks, both interacted with the father's occupational category. Those two variables try to capture the predicted risk factor and unanticipated shocks for households, respectively. Past rainfall volatility provides information about the risky environment of village. The riskiness of village may have an effect on the assets of household and its liquidity constraints. Fitzsimons (2007) indicates that the interaction with occupation and past rainfall volatility may explain whether the household is exposed to the risk of weather volatility. Households that rely on the agricultural sector may be exposed more to the weather risk than households in the non-agricultural sector. This chapter argues that households who are exposed to riskier environments are more likely to be liquidity constrained.

Rainfall shocks capture information about unanticipated weather and its effect on household liquidity constraint status. Jacoby and Skoufias (1997) present evidence showing village level rainfall "surprises" explain the unanticipated income shocks and liquidity constraints of households. The shocks are not expected to directly affect children's human capital accumulation, but have an indirect effect through household's income shocks and liquidity constraints.

Using these instrumental variables, the first stage equation for equations (2.12) and (2.13) is specified as follows:

$$L_{h,c,t} = \sum_{i=1}^{I} \gamma COMIV_{i,c,t} + \sum_{i=1}^{I} \delta HHIV_{i,h,c,t} + + \sum_{i=1}^{I} \theta_i X_{i,h,c,t} + \zeta_c + \varepsilon_{i,h,c,t} \tag{2.14}$$

where $L_{h,c,t}$ is liquidity constraints variable, which is categorical variable: one indicates that household answers "Yes,", two indicates that household answers "Probably," and three indicates that household answers "No," to Question 1 in Section 2.4. $COMIV_{c,t}$ are community level instrumental variables such as a dummy for the existence of subsidized credit programs and a dummy for the existence of savings cooperatives in the community. $HHIV_{h,c,t}$ are household level instrumental variables such as a dummy for the existence of relatives in community, the interaction between past rainfall and father's occupation, and the interaction between rainfall shocks and father's occupation. The variable ζ_c allows for community-specific fixed effects and $\varepsilon_{i,h,c,t}$ is an error term.

The main concern of using instrumental variables is whether they are valid instruments. As explained in Angrist and Pischke (2008) and Wooldridge (2010), there are two required conditions for a valid instrumental variable. First, the instrumental variable should have a statistically significant effect on the endogenous variable, conditional on all other variables in the equation of interest. This assumption can be tested by examining the first stage and it's F-statistics. I report and discuss about the result of first stage in Section 6.

The second requirement of an instrumental variable is that it should not have a causal impact on the dependent variable in the equation of interest after conditioning on the explanatory variables in that equation (exclusion restriction). This implies that it should not be correlated with the error term in the equation of interest. Fitzsimons (2007) presented evidence showing that past rainfall variability in Indonesia is exogenous to educational choices in the future. This chapter also conducts over-identification test to see whether the instrumental variables are valid, and most of the specifications in this chapter pass the over-identification test.

In addition, this chapter conducts weak instrumental variable test. Bound, Jaeger, and Baker (1995) suggest to use a "fake" instrument and compare the result with TSLS analysis. The result of TSLS using "fake" instrumental variable is reported in Table A1 in the Appendix. The estimation result for the younger and older cohorts children in Round 2 is very different from the original IV results in Table 2.8, and it tells us that the instrumental variables used in this chapter are valid.

2.6 Results

2.6.1 OLS Estimates of the Effect of Current Liquidity Constraints on Children's Current Test Scores using OLS

The OLS estimates of equation (2.12), which measure the effect of current liquidity constraints on children's test scores, are presented in Table 2.2 (younger cohort in Round 2), Table 2.3 (older cohort in Round 2), Table 2.4 (younger cohort in Round 3), and Table 2.5 (older cohort in Round 3).

The liquidity constraints variable has three possible values. The first indicates that the household can raise 230,000 VND (Round 2) or 300,000 VND (Round 3) in one week, the second indicates that households can "probably" raise that amount of money, and the third is that households "cannot" raise the money. To see the effect of liquidity constraints on children's test scores, the first category is omitted in the regression. The coefficients for the variables "probably can raise" and "cannot raise" in Table 2.2–2.5 show whether liquidity constraints increase or decrease children's test scores. All test scores are standardized.

As seen in Table 2.2, OLS estimates indicate that current liquidity constraints negatively affect PPVT and CDA scores for the younger cohort in Round 2 when the younger cohort children were 4–5 years old. Even after controlling for individual characteristics and community fixed effects, the negative effect is robust. Liquidity constraints decrease children's PPVT test scores by about 0.036 standard deviations and CDA scores by about 0.215 standard deviations (columns 2 and 4 of Table 2.2). The younger cohort's test scores are negatively affected by current liquidity constraints in Round 3 as well, when they were 7–8 years old. Liquidity constraints lower children's PPVT scores by 0.126 standard deviations and Mathematics Achievement test scores by 0.262 standard deviations (column 2 and 4 of Table 2.4).

However, as seen in Tables 2.3 and 2.5, the effect of liquidity constraints on the older cohort's test scores is not consistent. Child's test score for the household who answered "Probably can raise the money" is higher than unconstrained children by 0.0567 standard deviations, when older cohort were 11–12 years old (Column 2 in Table 2.3). Also there is positive effect from liquidity constraints on older cohort's PPVT score when older cohort were 14–15 years old (Column 1 in Table 2.5). However, there is no significant effect from liquidity constraint ("Can not raise the money") after one controls for individual characteristics and community fixed effects (Column 2 in Table 2.5).

The results indicate that liquidity constraints have significant effects on younger children. The younger cohort were aged 4 to 5 in Round 2 and aged 7 to 8 in Round 3. The liquidity constraints lower the younger cohort's test scores in both rounds. However, the older cohort children were aged 11 to 12 in Round 2, and 14 to 15 when Round 3 was implemented, and their test scores were not severely affected by households' liquidity constraints. One possible explanation is that liquidity constraint has more effect for children in their early stage of life. The critical time for developing human capital may be 0–5 years old, and the liquidity constraint has severe effect on human capital development at that time (or early elementary school age). The liquidity constraint is more "out of date" for older cohort when they were aged 11–12 and 14–15.

2.6.2 OLS Estimates of Dynamic Effect of Liquidity Constraints on Test Scores using OLS

Table 2.6 presents OLS estimates of the effect of early liquidity constraints on later test scores (equation (2.13)). The younger cohort in Panel A of the table were 4 to 5 years old in Round 2 when the information about liquidity constraints was collected. The PPVT and math tests were taken in Round 3, when these children were 7 to 8 years old. Column (3) for younger cohort suggests that the liquidity constraints when children were 4 to 5 years old decrease their math test scores three years later by 0.18 standard deviations. This result is smaller and not statistically significant, however, when community fixed effects are added to the regression.

The results in Panel B in Table 2.6 show analogous results for the older cohort children. The older cohort children were 11 to 12 years old when the liquidity constraints information was collected and were 14 to 15 years old when the PPVT and math tests were taken. The results are mixed. The liquidity constraints when children were 11-12 years old decrease children's PPVT scores by 0.193 standard deviations after three years (column 1 for Panel B in Table 2.6). The effect is smaller and not significant, however, when the community fixed effects are added. What's interesting to observe in this table is that the variable "cannot raise in Round 3" increases the older cohort's test scores by 0.09 standard deviations (column 1 for Panel B in Table 2.6). However the positive effect diminish when community fixed effect is added.

One can argue that the liquidity constraints in Rounds 2 and 3 may be strongly correlated with each other. The collinearity, caused by strong correlation between two independent variables, increases the standard error of the coefficients. It can cause the coefficient of a variable not to be statistically significant. To deal with this issue, this chapter conducts same analysis as Table 2.6 but without the liquidity constraints variable in Round 3. Table A2 in the Appendix presents the result of analysis using only the liquidity constraints in Round 2. The effect of liquidity constraints for Round 2 in Table 2.6 and in Table A2 are mostly the same: the liquidity constraints in Round 2 decreases the younger cohort's Math test score by 0.195 standard deviations and the older cohort's PPVT score by 0.188 standard deviations (Table A3).

2.6.3 Instrumental Variables Estimates

Table 2.7 presents estimates of the determinants of liquidity constraints for the younger cohort in Round 2.[18] These are the first stage results for the IV estimates in Table 2.8 and 2.9 of the effect of liquidity constraints on children's human capital accumulation. The dependent variable in the first stage is the liquidity constraint status of a household. The liquidity constraint variable is a categorical variable : one is for "can raise the money," two is for "probably can raise the money," and three is for "can not raise the money." This table shows only the coefficients for the instrumental variables; the other variables included in the human capital equation (e.g., age, sex, and father's education etc.) are excluded. Specification A includes a dummy for the existence of relatives, a dummy for the existence of subsidized credit programs, and a dummy for the existence of a savings cooperative as the instrumental variables. Specification B adds past rainfall volatility and the interaction of past rainfall volatility and occupation to specification A. Specification C adds rainfall shocks and the interaction of rainfall shocks and occupation, but excluded past rainfall volatility. Finally, specification D includes all instrumental variables: a dummy for the existence of relatives, a dummy for the existence of subsidized credit programs, a dummy for the existence of a savings cooperative, past rainfall volatility and its interaction with occupation, and rainfall shocks and its interaction with occupation.

The first column of each specification (columns 1, 3, 4, and 7) include child and household characteristics as regressor but exclude community fixed effects. The second column of each specification (columns 2, 4, 6, and 8) include both individual and household characteristics and community fixed effects. F-statistics at the bottom of the table indicate whether variables in the first stage significantly estimate the liquidity constraints variable.

Bound, Jaeger, and Baker (1995) persuasively argue that there are two problems when

[18] Table 2.7 shows the first stage result of the determinants of liquidity constraints only for the younger cohort in Round 2. The results are very similar for older cohort children in Round 2 and for both cohorts in Round 3.

using weak instruments: inconsistency and finite sample bias. The first problem is that weak instruments may lead to inconsistency in IV estimates if the instrumental variables are correlated with the error term in the second stage; for example, if the existence of a credit program in the community is related to the error term in the second stage, then the estimated endogenous variables will be correlated with the error term. In this case, the IV estimator will be inconsistent. The extent of the inconsistency depends on how much the instrumental variable predicts the endogenous variable. So the weaker the instrument, the larger the inconsistency.

The second problem discussed by Bound, Jaeger, and Baker (1995) is finite sample bias. Even if the instrumental variables are not correlated with the error term, weak instrumental variables can lead to bias when the sample is finite. Bound, Jaeger, and Baker (1995) showed that low F-statistics (close to one) in the first stage means that the bias using IV estimates is almost as large as the bias in the OLS estimates. However, a large F-statistic in the first stage means that bias in IV estimates is much smaller than that in OLS estimates.

The F-test of the first stage regression can be used to check for finite sample bias. Stock and Yogo (2005) suggested that the first stage F-statistics should be above five to avoid biased results when there is one endogenous variable and multiple, but weak, instrumental variables.

The F-statistics for specifications A, B, and C imply that the instrumental variables are not valid when the community fixed effects are included in the analysis. The F-statistics without the community fixed effects are either above or around five. But the F-statistics are far lower when community fixed effects are added. Specification D, which includes all instrumental variables, has F-statistics below the critical points even without community fixed effect. Thus specification D has a weak instrumental variable problem.[19]

[19]The P-value of over-identification test is 0. for Specification D, however, which indicates that there is no exclusion restriction problem in Specification D. However, since it has low R-squared, the estimators in Specification D is not reliable.

The rest of this section considers specifications A, B, and C without the community fixed effects and compares the IV estimation results with those of OLS. The OLS results throughout Table 2.6 tell us that community fixed effect are important since adding community fixed effects changes the size of effect or the significant level of it. Ideally, the IV estimation with community fixed effects will give us the most unbiased estimation of liquidity constraints effect. However, the very low F-statistics for the first stage of IV estimation with community fixed effects implies that those estimates are not reliable. The community fixed effects are used to control for the socio-economic status of the community. The instrumental variables used in this chapter also capture the information of the community. The rainfall volatility and rainfall shocks are measured at the community level, and they include information on whether the community has been exposed to the risk from weather shocks in the past, and currently. The information about the existence of savings cooperatives and credit programs also tells us about the existence of financial infrastructure in the community. In addition, to see whether the community fixed effect makes large differences in the OLS analysis, this chapter conducts a Hausman-type test, checking the consistency between two OLS analyses: one without community fixed effects and one with community fixed effects for younger cohorts in Round 2.[20] The P-value of the test is 0.166, so one cannot reject the null hypothesis that the difference between the estimates without community fixed effects and the estimates with community fixed effects are identified. This suggests that it is reasonable to consider only the estimates without community fixed effects.

The first-stage equation indicates that the existence of subsidized credit programs in the community decreases the possibility that the household is liquidity constrained. In contrast, the existence of a savings cooperative increases the possibility of the household to be liquidity constrained. The existence of relatives in the community has no significant effect on whether a household is liquidity constrained. Rainfall volatility in wet season has negative effect on households' liquidity constraints. The higher the coefficient of variation

[20]The Hausman-type test is a generalized type of Hausman test. The original Hausman test does not allow for clustering. The generalized version, however, adjust for clustering. For more details about the Hausman-type test, please see Hausman (1978) and Weesie (2000).

in wet season (1979-1993), the higher the probability that household answer "cannot raise the money." The effect is different depending on the father's occupation: there are more possibility for wage worker in the agricultural sector than self-employed worker in the agricultural sector to be liquidity constrained when there is rainfall volatility. Rainfall shocks have a negative effect on household liquidity constraints (Column 5 and 7 in Table 2.7): the greater the deviation of rainfalls in wet season were find, the higher the probability that the household is liquidity constrained, even though it is not significant in Column 5. This is what one would expect; households that face greater risks would have more difficulty obtaining credit and other sources of funds.

IV estimates of the effect of current liquidity constraints on children's current test scores are presented in Table 2.8. The estimated effects of liquidity constraints on the test scores of the younger cohort children in Round 2 are negative and significant. Liquidity constraints decrease the younger cohort children's PPVT and math test scores by 0.536 and 2.117 standard deviations, respectively, in specification A. The negative effect of liquidity constraints is consistent in specification B: liquidity constraints decrease the younger cohort children's PPVT and math test scores by 0.181 and 0.953 standard deviations. The results are similar in specification C. The estimated effects of liquidity constraints on the older cohort children's test scores are not significant and in some cases are even positive (PPVT score in Specifications A and B for older cohort Round 2). Recalling the OLS estimation results for older cohorts in Round 2 (Tables 2.2 and 2.3), these results are consistent with the OLS analysis that only younger cohort's non-cognitive skills are negatively affected by liquidity constraints.

In Round 3, the effect of liquidity constraints is mixed. The younger cohort's PPVT score is negatively affected by liquidity constraints in Specification A (Column 1 in Table 2.8), while there is also positive effect from liquidity constraints on younger cohort's Math score (Column 2) and older cohort's PPVT and Math score (Columns 3 and 4).

Table 2.9 presents the effect of liquidity constraints in Round 2 on children's test scores three years later in Round 3. The results indicate that liquidity constraints in the early stage of childhood have a negative effect on children's test scores in the later stage only for younger cohort. The size of the effect for the younger cohort children is 0.3–0.5 standard deviations. The effect is not statistically significant for older cohort. Again this result indicate that the liquidity constraints for older cohort when they were 11–12 years old may be "out of date," and does not affect child's human capital development.

2.7 Conclusion

This chapter examines the effect of liquidity constraints on children's cognitive skills, as measured by test scores, in Vietnam. Theory suggests that children's human capital accumulation depends on parents' liquidity constraints: parents may underinvest in a child's human capital when they face liquidity constraints. The timing of a child's human capital investment matter, because human capital begins to develop in early childhood, and early human capital directly affects later production of human capital. By examining the effect of liquidity constraints on children's cognitive test scores at different ages, this chapter searches for evidence of the effect of liquidity constraints on children's human capital accumulation and the importance of timing in child human capital investment.

To overcome the potential bias from OLS estimates, this chapter employs IV estimates using several instrumental variables: past rainfall volatility, rainfall shocks, a dummy for the existence of relatives in the community, a dummy for the existence of subsidized credit programs in the community, and a dummy for the existence of a savings cooperative in the community. Those instrumental variables exploit information about the financial environment of the household.

The first stage analysis tells us that the existence of subsidized credit programs decreases the possibility of household being liquidity constrained. The rainfall volatility affects liquidity constraints differently depending on the household's income source. The interaction of rainfall volatility with the father's occupation shows a larger effect when the rainfall is interacted with the wage worker in agricultural sector. Rainfall shocks weakly predict the liquidity constraints of a household, but it has negative effect on the status of liquidity constraints.

Results suggest that children's cognitive test scores are negatively affected by liquidity constraints. The empirical results using both the OLS and IV estimates indicate that liquidity constraints decrease children's test scores. The size of effect and the significance level is different by child's age in both OLS and IV estimates. Liquidity constraint lower younger cohort children's test score by 0.1–0.3 standard deviations in Round 3, while the effect was not significant for older cohort children with OLS. The IV results tell us that liquidity constraints lower younger cohort children's test scores by 0.3–0.9 standard deviations, but do not have any significant and consistent effect on older cohort children's test scores.

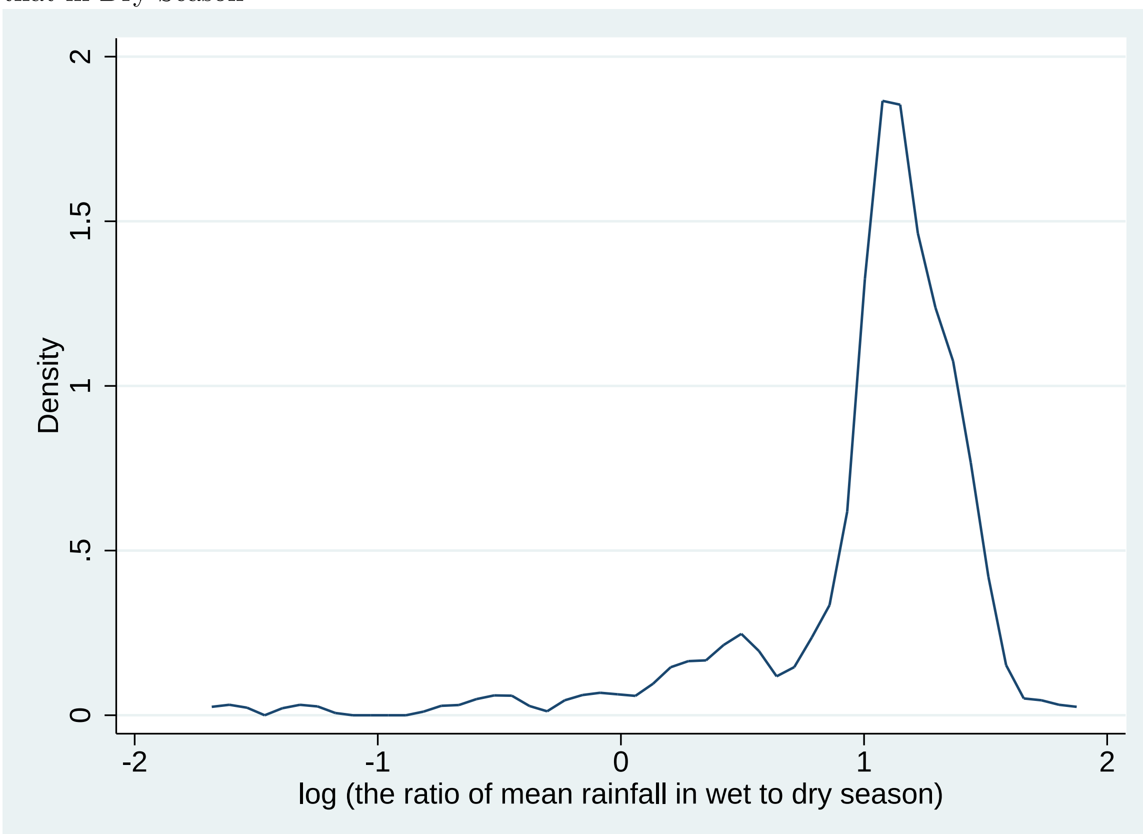
The overall result presented in this chapter is consistent with other literature that emphasizes the importance of liquidity constraints on human capital investment, such as Carneiro and Heckman (2002) and Devicienti and Rossi (2013). The difference in the effect of liquidity constraints on human capital by a child's age is supported by the literature, which shows the importance of early investment to enhance human capital accumulation. For example, Brooks-Gunn and Duncan (1997) presented empirical evidence that a family's income during a child's early age (preschool and early school years) has a significant effect on the child's cognitive skills, and Heckman (2000) showed that education during early childhood has a high internal rate of return. Other papers indicate the effectiveness of programs that subsidize poor families so that they invest in their children's human capital (Currie and Thomas, 2000; Campbell et al., 2008; Heckman et al., 2010; Reynolds et al., 2011).

The evidence found in this chapter has an important implication for future studies on

Vietnam's educational policy. Since education is one of the growth engines for developing countries (Lucas, 1988; Glewwe, 2002; Hanushek and Woessmann, 2008), policies to enhance education should be a priority in developing countries. Vietnam, as one of the fastest growing developing countries in the world, has also implemented various educational policies in order to increase student learning. Most government policies in Vietnam to increase education focus on the supply side. These policies include training teachers, improving school resources and facilities, and supporting full-day-schooling (FDS) and early childhood programs (World Bank, 2011). However, there are few interventions on the demand side of education. The World Bank (2011) indicated that tuition fees for secondary school and indirect schooling costs, such as uniforms, transportation, tutoring, boarding costs etc., are the main obstacle for Vietnamese households to increase children's education. As seen in the first stage analysis of this chapter, the existence of subsidized credit programs in the community lowers the probability that a household is liquidity constrained, and it indirectly affects students' learning. Thus, policy-makers should consider programs that provide an appropriate intervention to reduce households' liquidity constraints in order to increase student learning. This chapter shows that the negative effect of liquidity constraints' on children's human capital is largest when children are younger. The effect is smaller or not significant for older children. This suggests that credit programs that ease households' liquidity constraints should target those with young children to maximize their impact on student learning.

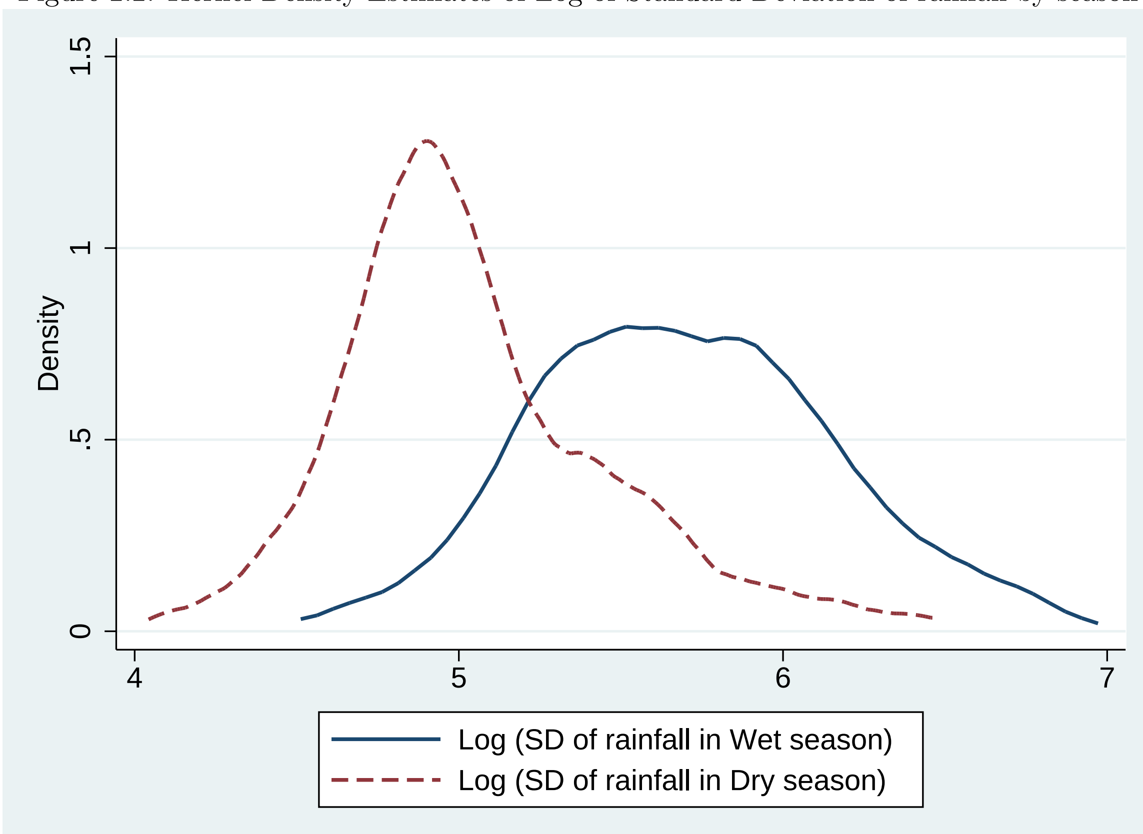
2.8 Figures and Tables

Figure 2.1: Kernel Density Estimates of Log of Ratio of Mean Rainfall in Wet Season to that in Dry Season



Source: Data from Thomas et al. (2010)

Figure 2.2: Kernel Density Estimates of Log of Standard Deviation of rainfall by season



Source: Data from Thomas et al. (2010)

Table 2.1: Summary Statistics

	All		Liquidty=1		Liquidty=2		Liquidty=3	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Younger Cohort in Round 2								
No. of Observation	1456		743		572		141	
PPVT score	35.79	16.85	39.00	17.45	33.41	15.61	28.37	14.47
CDA score	9.72	2.37	10.31	2.17	9.26	2.34	8.43	2.58
Age in months	63.53	3.70	63.75	3.56	63.26	3.69	63.43	4.33
Female	0.52	0.50	0.51	0.50	0.53	0.50	0.56	0.50
Mother's education (yrs)	6.54	3.73	7.57	3.63	5.79	3.41	4.15	3.70
Father's education (yrs)	7.29	3.74	8.41	3.48	6.47	3.63	4.63	3.32
Mother's religion is catholic	0.01	0.12	0.01	0.11	0.02	0.13	0.02	0.14
_ buddism	0.04	0.19	0.03	0.17	0.05	0.22	0.02	0.14
_ protestant	0.01	0.09	0.01	0.08	0.01	0.08	0.03	0.17
_ Cao Dai	0.01	0.10	0.01	0.11	0.01	0.10	0.01	0.10
_ none	0.93	0.26	0.94	0.24	0.91	0.28	0.92	0.28
_ Hoa Hao	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.10
Household size	4.72	1.52	4.65	1.46	4.78	1.61	4.81	1.46
Live in Rural	0.86	0.35	0.83	0.38	0.87	0.33	0.92	0.28
BMI	16.06	1.41	16.09	1.44	15.99	1.37	16.13	1.39
Total income (VND)	18,127	36,000	25,342	47,579	11,616	13,783	6,107	6,868
Older Cohort in Round 2								
No. of Observation	812		430		279		93	
PPVT	137.73	24.89	140.86	21.47	137.34	25.95	124.26	32.43
Math	7.57	1.69	7.82	1.47	7.37	1.84	6.90	1.83
Age in months	147.48	4.07	147.77	3.97	147.40	4.19	146.40	4.08
Female	0.50	0.50	0.51	0.50	0.49	0.50	0.47	0.50
Mother's education (yrs)	6.75	3.74	7.70	3.59	6.08	3.62	4.41	3.23
Father's education (yrs)	7.69	3.79	8.78	3.52	7.02	3.67	4.64	3.23
Mother's religion is catholic	0.02	0.14	0.02	0.15	0.01	0.12	0.01	0.12
_ buddism	0.04	0.19	0.02	0.15	0.07	0.25	0.03	0.17
_ protestant	0.01	0.10	0.00	0.00	0.02	0.14	0.01	0.12
_ Cao Dai	0.01	0.10	0.01	0.08	0.01	0.10	0.03	0.17

Table 2.1 – Continued

	All		Liquidity=1		Liquidity=2		Liquidity=3	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
_ none	0.92	0.26	0.95	0.23	0.89	0.31	0.91	0.28
_ Hoa Hao	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Household size	4.96	1.38	4.83	1.23	5.06	1.55	5.29	1.52
Live in Rural	0.81	0.39	0.84	0.37	0.78	0.42	0.81	0.39
BMI	14.23	1.28	14.17	1.26	14.27	1.34	14.36	1.25
Total income	16,978	21,651	21,028	23,065	13,632	21,127	8,051	8,301
Younger Cohort in Round 3								
No. of Observation	1456		589		819		48	
PPVT score	93.14	26.44	98.10	26.89	90.79	25.88	80.96	21.65
Math score	19.17	5.85	20.16	5.58	18.70	5.98	16.96	5.06
age in months	97.00	3.73	96.89	3.60	97.05	3.78	97.38	4.21
Female	0.52	0.50	0.53	0.50	0.51	0.50	0.50	0.51
Mother's education (yrs)	6.54	3.73	7.63	3.43	6.06	3.73	3.33	3.15
Father's education (yrs)	7.29	3.73	8.37	3.53	6.76	3.70	4.85	3.38
Mother's religion is catholic	0.01	0.12	0.01	0.11	0.02	0.13	0.00	0.00
_ buddism	0.04	0.19	0.05	0.22	0.03	0.17	0.00	0.00
_ protestant	0.01	0.09	0.00	0.07	0.01	0.11	0.00	0.00
_ Cao Dai	0.01	0.10	0.01	0.08	0.01	0.10	0.04	0.21
_ none	0.93	0.26	0.92	0.26	0.92	0.26	0.96	0.21
_ Hoa Hao	0.00	0.03	0.00	0.00	0.00	0.04	0.00	0.00
Household size	4.72	1.52	4.73	1.63	4.70	1.45	5.02	1.53
Live in Rural	0.86	0.35	0.84	0.36	0.87	0.34	0.83	0.38
BMI	16.06	1.41	16.17	1.42	16.01	1.40	15.70	1.26
Value of assets (mil)	0.33	3.27	0.72	5.26	0.10	0.48	0.04	0.10
Older Cohort in Round 3								
No. of Observation	812		343		431		48	
PPVT score	168.51	26.21	172.79	22.18	164.95	28.57	172.71	23.96
Math score	18.38	7.13	19.13	6.86	17.83	7.38	18.39	6.08
age in months	181.09	3.86	181.10	3.87	181.13	3.91	180.35	3.10
Female	0.50	0.50	0.50	0.50	0.51	0.50	0.32	0.48
Mother's education (year)	6.75	3.74	7.98	3.43	6.01	3.76	4.68	2.84

Table 2.1 – Continued

	All		Liquidity=1		Liquidity=2		Liquidity=3	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Father's education (year)	7.69	3.79	8.85	3.75	6.95	3.65	6.36	3.14
Mother's religion is catholic	0.02	0.14	0.03	0.17	0.01	0.11	0.00	0.00
_ buddism	0.04	0.19	0.04	0.19	0.04	0.19	0.00	0.00
_ protestant	0.01	0.10	0.01	0.09	0.01	0.11	0.00	0.00
_ Cao Dai	0.01	0.10	0.01	0.11	0.01	0.09	0.00	0.00
_ none	0.92	0.26	0.91	0.28	0.93	0.26	1.00	0.00
_ Hoa Hao	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Household size	4.96	1.38	4.91	1.30	4.99	1.42	5.00	1.49
Live in Rural	0.81	0.39	0.82	0.38	0.82	0.38	0.68	0.48
BMI	14.23	1.28	14.19	1.20	14.27	1.37	14.14	0.87
Value of assets (mil)	0.53	4.77	1.20	7.44	0.07	0.26	0.03	0.04

Notes: 1.PPVT, CDA, and Mathematics test scores are not standardized in this table. 2. "Liquidiyt=1" means that the household answers "Yes, I can raise the money", "Liquidiyt=2" means that the household answers "Probably I can raise the money", "Liquidiyt=3' means that the household answers "No, I can't raise the money"

Table 2.2: OLS Estimation of Effect of Liquidity Constraints on Child Test Score in Round 2 (Younger cohort)

VARIABLES	(1) PPVT	(2) PPVT	(3) CDA	(4) CDA
Liquidity Constraints				
Probably can raise	-0.0337*	-0.0152	-0.201***	-0.0752
	(0.0187)	(0.0144)	(0.0646)	(0.0496)
Cannot raise	-0.0622**	-0.0368*	-0.408***	-0.215***
	(0.0269)	(0.0196)	(0.109)	(0.0717)
Individual Covariates				
Age in months	0.0165***	0.0173***	0.0467***	0.0376***
	(0.00302)	(0.00225)	(0.00810)	(0.00605)
Female	0.0156	0.0209	-0.0121	0.00359
	(0.0178)	(0.0172)	(0.0508)	(0.0518)
Mother's education level(yrs)	0.0178***	0.0165***	0.0341**	0.0377***
	(0.00396)	(0.00322)	(0.0153)	(0.00872)
Father's education level(yrs)	0.00940***	0.0119***	0.0329***	0.0316***
	(0.00294)	(0.00244)	(0.00925)	(0.00664)
Mother's religion is catholic	0.123	0.0918	-0.0254	-0.0247
	(0.0849)	(0.0676)	(0.222)	(0.158)
_ buddism	-0.00717	-0.000304	-0.0713	0.00173
	(0.0302)	(0.0202)	(0.0956)	(0.104)
_ protestant	0.0806*	0.0475	-0.0336	-0.107
	(0.0460)	(0.0681)	(0.215)	(0.165)
_ Cao Dai	-0.133	-0.0656	-0.373	-0.00465
	(0.0876)	(0.0852)	(0.229)	(0.230)
_ Hoa Hao	-0.132***	-0.0476**	0.274*	0.110
	(0.0361)	(0.0215)	(0.137)	(0.0854)
Household size	-0.00731	-0.00192	-0.0440*	-0.00282
	(0.00565)	(0.00490)	(0.0220)	(0.0151)
Live in rural	-0.184***	0.0281	-0.270**	-0.0898
	(0.0512)	(0.0572)	(0.118)	(0.186)
BMI	-0.000499	-0.00503	-0.00921	-0.00528
	(0.00462)	(0.00482)	(0.0159)	(0.0139)
Total income (mil. VND)	0.891***	0.511***	2.123**	0.878**
	(0.232)	(0.147)	(0.848)	(0.426)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	1,456	1,456	1,456	1,456
R-squared	0.293	0.437	0.206	0.424

Notes: 1. Liquidity Constraints : "Can raise 230,000 VND" is the omitted category. 2. Test scores are standardized. 3.Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table 2.3: OLS Estimation of Effect of Liquidity Constraints on Child Test Score in Round 2 (Older cohort)

VARIABLES	(1) PPVT	(2) PPVT	(3) Math	(4) Math
Liquidity Constraints				
Probably can raise	0.0558	0.0567**	0.00140	0.00259
	(0.0332)	(0.0210)	(0.0926)	(0.0924)
Cannot raise	-0.0273	0.00125	-0.0338	0.00190
	(0.0547)	(0.0484)	(0.136)	(0.155)
Individual Covariates				
Age in months	0.0150***	0.0131***	0.0121	0.00944
	(0.00342)	(0.00331)	(0.00804)	(0.00805)
Female	0.00689	0.0483*	-0.103	-0.0550
	(0.0269)	(0.0254)	(0.0638)	(0.0600)
Mother's education level(yrs)	0.0279***	0.0187***	0.0557***	0.0466***
	(0.00641)	(0.00518)	(0.0133)	(0.0122)
Father's education level(yrs)	0.0197**	0.0216***	0.0475***	0.0471***
	(0.00736)	(0.00426)	(0.0128)	(0.0126)
Mother's religion is catholic	0.0608	0.0368	0.151	0.0888
	(0.0530)	(0.0330)	(0.125)	(0.178)
_ buddism	-0.0834	-0.0738	0.0636	0.0502
	(0.0814)	(0.0832)	(0.109)	(0.0980)
_ protestant	-0.393*	-0.405	-0.651	-0.493
	(0.198)	(0.282)	(0.427)	(0.443)
_ Cao Dai	-0.208	-0.351*	-0.377	-0.657***
	(0.181)	(0.173)	(0.251)	(0.163)
Household size	-0.0549***	-0.0205*	-0.0787**	-0.0348
	(0.0169)	(0.0109)	(0.0297)	(0.0262)
Live in rural	-0.145***	0.0638	-0.140	0.352
	(0.0463)	(0.0902)	(0.0927)	(0.279)
BMI	-0.0309	-0.0117	-0.0216	0.00458
	(0.0227)	(0.0138)	(0.0383)	(0.0305)
Total income (mil. VND)	1.538**	0.399	2.546*	0.0900
	(0.614)	(0.373)	(1.348)	(1.241)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	812	812	812	812
R-squared	0.315	0.520	0.226	0.305

Notes: 1. Liquidity Constraints : "Can raise 230,000 VND" is the omitted category. 2. Test scores are standardized. 3.Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table 2.4: OLS Estimation of Effect of Liquidity Constraints on Child Test Score in Round 3 (Younger Cohort)

VARIABLES	(1) PPVT	(2) PPVT	(3) Math	(4) Math
Liquidity Constraints				
Probably can raise	-0.0487	-0.0490	-0.0885*	-0.163***
	(0.0410)	(0.0363)	(0.0468)	(0.0384)
Cannot raise	-0.107*	-0.126***	-0.161**	-0.262***
	(0.0596)	(0.0384)	(0.0772)	(0.0723)
Individual Covariates				
Age in months	0.0330***	0.0299***	0.0747***	0.0663***
	(0.00425)	(0.00390)	(0.00874)	(0.00730)
Female	0.0165	0.00761	-0.0445	-0.0535
	(0.0232)	(0.0229)	(0.0392)	(0.0372)
Mother's education level(yrs)	0.0499***	0.0378***	0.0464***	0.0380***
	(0.00657)	(0.00570)	(0.00976)	(0.00847)
Father's education level(yrs)	0.0242***	0.0171***	0.0530***	0.0365***
	(0.00453)	(0.00432)	(0.00772)	(0.00657)
Mother's religion is catholic	-0.0388	-0.149*	-0.394**	-0.0316
	(0.0716)	(0.0797)	(0.160)	(0.171)
_ buddism	0.120	-0.156	-0.358***	-0.107
	(0.215)	(0.151)	(0.0918)	(0.108)
_ protestant	-0.155	-0.339**	-0.468**	-0.270
	(0.150)	(0.127)	(0.172)	(0.213)
_ Cao Dai	-0.209*	-0.220**	-0.477*	-0.199
	(0.106)	(0.108)	(0.256)	(0.222)
_ none	-0.0907**	-0.175***	-0.474***	-0.144***
	(0.0438)	(0.0179)	(0.0710)	(0.0253)
_ Hoa Hao	-0.533***	-0.515***	-0.0510	-0.125*
	(0.0553)	(0.0424)	(0.0812)	(0.0739)
Household size	-0.0159*	-0.0148**	-0.0147	-0.00439
	(0.00780)	(0.00590)	(0.0170)	(0.0106)
Live in rural	-0.0245	0.0706	-0.171*	0.203
	(0.106)	(0.115)	(0.0982)	(0.177)
BMI	0.00891	0.00310	0.0177	0.0250**
	(0.00891)	(0.00868)	(0.0155)	(0.0116)
Value of assets (mil)	-0.0043**	-0.0066***	-0.0060	-0.0077
	(0.00188)	(0.00109)	(0.00550)	(0.00469)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	1,456	1,456	1,456	1,456
R-squared	0.286	0.392	0.311	0.414

Notes: 1. Liquidity Constraints : "Can raise 300,000 VND" is the omitted category. 2. Test scores are standardized. 3.Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table 2.5: OLS Estimation of Effect of Liquidity Constraints on Child Test Score in Round 3 (Older Cohort)

VARIABLES	(1) PPVT	(2) PPVT	(3) Math	(4) Math
Liquidity Constraints				
Probably can raise	-0.0647	-0.0341	0.0446	0.00945
	(0.0405)	(0.0321)	(0.0797)	(0.0769)
Cannot raise	0.110*	-0.0116	-0.0340	-0.154
	(0.0604)	(0.0565)	(0.173)	(0.154)
Individual Covariates				
Age in months	0.00599	-0.000165	0.000951	-0.00174
	(0.00727)	(0.00533)	(0.0122)	(0.0105)
Female	0.0107	0.0261	-0.289***	-0.246***
	(0.0415)	(0.0330)	(0.0662)	(0.0655)
Mother's education level(yrs)	0.0289***	0.0203***	0.0612***	0.0533***
	(0.00794)	(0.00649)	(0.0165)	(0.0152)
Father's education level(yrs)	0.0268***	0.0208**	0.0611***	0.0606***
	(0.00928)	(0.00792)	(0.0138)	(0.0135)
Mother's religion is catholic	-0.286	-0.244	0.238	0.0281
	(0.195)	(0.217)	(0.504)	(0.473)
_ buddism	-0.397**	-0.411*	-0.0710	-0.214
	(0.195)	(0.232)	(0.540)	(0.489)
_ protestant	-0.845***	-0.926**	-0.369	-0.192
	(0.274)	(0.406)	(0.594)	(0.740)
_ Cao Dai	-0.513	-0.681**	-0.0214	-0.819
	(0.322)	(0.274)	(0.543)	(0.503)
_none	-0.221	-0.284	0.0196	-0.106
	(0.167)	(0.196)	(0.429)	(0.426)
Household size	-0.0288	-0.000384	-0.0469**	-0.0121
	(0.0189)	(0.0139)	(0.0224)	(0.0256)
Live in rural	-0.242*	0.131	-0.355	0.989***
	(0.129)	(0.0802)	(0.263)	(0.155)
BMI	-0.0207	-0.00475	0.00842	-0.00620
	(0.0210)	(0.0126)	(0.0264)	(0.0273)
Value of assets (mil)	0.00109	0.000660	-0.00484	-0.00107
	(0.00198)	(0.000890)	(0.00321)	(0.00260)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	812	812	812	812
R-squared	0.222	0.437	0.222	0.348

Notes: 1. Liquidity Constraints : "Can raise 300,000 VND" is the omitted category. 2. Test scores are standardized. 3.Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table 2.6: OLS Estimation of Effect of Early (Round 2) and Current Liquidity Constraints (Round 3) on Child Test Score (Round 3) by cohort

VARIABLES	(1) PPVT	(2) PPVT	(3) Math	(4) Math
Panel A: Younger Cohort				
Probably can raise in Round 2	-0.0124	-0.0222	-0.114*	-0.0475
	(0.0371)	(0.0305)	(0.0579)	(0.0497)
Cannot raise in Round 2	-0.0694	-0.0455	-0.180*	-0.0381
	(0.0525)	(0.0426)	(0.0985)	(0.0862)
Probably can raise in Round 3	-0.0332	-0.0389	-0.0319	-0.143***
	(0.0375)	(0.0358)	(0.0509)	(0.0410)
Cannot raise in Round 3	-0.0994	-0.118***	-0.133	-0.251***
	(0.0609)	(0.0382)	(0.0802)	(0.0685)
Observations	1,456	1,456	1,456	1,456
R-squared	0.286	0.391	0.307	0.410
Panel B: Older Cohort				
Probably can raise in Round 2	0.00468	0.0558	0.0464	0.0453
	(0.0447)	(0.0391)	(0.104)	(0.108)
Cannot raise in Round 2	-0.193**	-0.0627	-0.124	-0.140
	(0.0919)	(0.0696)	(0.176)	(0.139)
Probably can raise in Round 3	-0.0521	-0.0414	0.0752	0.0144
	(0.0408)	(0.0340)	(0.0778)	(0.0803)
Cannot raise in Round 3	0.150**	-0.00235	-0.00174	-0.125
	(0.0730)	(0.0597)	(0.185)	(0.168)
Observations	812	812	812	812
R-squared	0.237	0.442	0.225	0.351
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y

Notes: 1. Liquidity Constraints : "Can raise 230,000 VND" is the omitted category. 2. Test scores are standardized. 3.Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1. 4. Individual covariates are: age, gender, mother's education, father's education, mother's religion, household size, a dummy for living in Rural, BMI, and household income.

Table 2.7: First Stage of Regression for Younger Cohort Children in Round 2

Specification	(A) (1)	(A) (2)	(B) (3)	(B) (4)	(C) (5)	(C) (6)	(D) (7)	(D) (8)
IV	D(Relatives), D(Credit program), D(Savings coop,)		(A) + past rainfall volatility)		(A) + rainfall shocks		(C) + past rainfall volatility	
D(subsidized credit program)	-	-	-		-0.0890*		-0.105**	
	0.199***		0.127***					
	(0.0391)		(0.0406)		(0.0468)		(0.0468)	
D(savings cooperations)	0.171***		0.176***		0.150**		0.160**	
	(0.0576)		(0.0606)		(0.0692)		(0.0690)	
D(Relatives in community)	-0.0390	-0.0531	-0.0156	-0.0573	0.0128	-0.0265	0.0122	-0.0399
	(0.0848)	(0.0859)	(0.0834)	(0.0856)	(0.0839)	(0.0861)	(0.0842)	(0.0866)
Father's occupation								
(1) Self-employed agriculture			6.624*	6.931*	-1.241**	0.999	-0.0358	-0.0207
			(3.594)	(3.602)	(0.630)	(0.997)	(0.561)	(0.568)
(2) Wage worker agriculture			7.093*	6.843*				
			(3.719)	(3.739)				
(3) Other agriculture			-229.1*	-244.5*				
			(134.6)	(135.7)				
(4) Self-employed non-agriculture			6.372*	6.660*	-1.081*	-0.266	-1.312*	-1.115
			(3.595)	(3.604)	(0.572)	(0.618)	(0.686)	(0.689)
(5) Wage worker non-agriculture			6.398*	6.684*	-0.555	-0.545	1.337	1.468
			(3.595)	(3.602)	(0.594)	(0.590)	(2.579)	(2.595)
(6) Other non-agriculture			6.073*	6.370*	-0.937	-0.0884		
			(3.601)	(3.607)	(0.585)	(0.650)		
Rainfall Volatility								
Coefficient of Variation in wet season (1979-1993)			27.47*					
			(14.39)					
Coefficient of Variation in dry season (1979-1993)			-60.97*					
			(33.18)					
Ratio of average rain in wet to dry (1979-1993)			7.529**				0.293	

Table 2.7 – Continued

IV	D(Relatives), D(Credit program), D(Savings coop,)		(A) + past rainfall volatility)		(A) + rainfall shocks		(C) + past rainfall volatility	
			(2.1)				(0.37)	
Rainfall Volatility X Father's occupation								
Wet season X (1)			-27.89*	-30.05**				
			(14.39)	(14.49)				
Wet season X (2)			-29.38**	-29.89**				
			(14.48)	(14.58)				
Wet season X (3)			172.5*	184.0*				
			(100.6)	(101.5)				
Wet season X (4)			-29.22**	-30.93**				
			(14.41)	(14.49)				
Wet season X (5)			-27.86*	-29.39**				
			(14.40)	(14.48)				
Wet season X (6)			-26.89*	-28.95**				
			(14.43)	(14.52)				
Wet season X (7)			-29.94**	-31.24**				
			(14.44)	(14.53)				
Dry season X (1)			61.32*	65.41*				
			(33.18)	(33.49)				
Dry season X (2)			63.05*	65.48*				
			(33.22)	(33.53)				
Dry season X (3)			390.1*	416.4*				
			(231.1)	(233.0)				
Dry season X (4)			62.61*	66.23**				
			(33.19)	(33.48)				
Dry season X (5)			61.27*	64.72*				
			(33.18)	(33.48)				
Dry season X (6)			60.28*	64.26*				
			(33.20)	(33.51)				
Dry season X (7)			63.42*	66.63**				
			(33.20)	(33.50)				
Ratio X (1)			-7.536**	-7.964**			-0.237	-0.187
			(3.617)	(3.645)			(0.195)	(0.195)

Table 2.7 – Continued

IV	D(Relatives), D(Credit program), D(Savings coop,)	(A) + past rainfall volatility)	(A) + rainfall shocks	(C) + past rainfall volatility	
Ratio X (2)	-7.663**	-7.870**			
	(3.628)	(3.658)			
Ratio X (4)	-7.535**	-7.932**		0.105	0.122
	(3.617)	(3.644)		(0.216)	(0.216)
Ratio X (5)	-7.452**	-7.847**		-0.425	-0.399
	(3.617)	(3.644)		(0.473)	(0.475)
Ratio X (6)	-7.348**	-7.772**		-0.237	-0.185
	(3.619)	(3.646)		(0.244)	(0.247)
Ratio X (7)	-7.690**	-8.051**			
	(3.619)	(3.647)			
Rainfall Shocks					
(a) Deviation of rain at q1 of wet season			0.00420	0.00480	
			(0.00615)	(0.00617)	
(b) Deviation of rain at q2 of wet season			0.0172	0.0289	
			(0.0131)	(0.0425)	
(c) Square of deviation of rain at q1 of wet season			3.13e-05	5.07e-06	
			(2.84e-05)	(4.62e-05)	
(d) Square of deviation of rain at q2 of wet season			-1.44e-05	1.21e-05	
			(2.41e-05)	(7.44e-05)	
(e) Deviation of rain at q1 of dry season			-0.0675	-0.141	
			(0.0719)	(0.264)	
(f) Deviation of rain at q2 of dry season			-0.0497*	-0.0862	
			(0.0264)	(0.130)	
(g) Square of deviation of rain at q1 of dry season			8.46e-05*	1.88e-05	
			(4.75e-05)	(1.39e-05)	
(h) Square of deviation of rain at q2 of dry season			-0.000162	-6.00e-07	

Table 2.7 – Continued

IV	D(Relatives), D(Credit program), D(Savings coop,)	(A) + past rainfall volatility)	(A) + rainfall shocks	(C) + past rainfall volatility
	(0.000102)		(2.53e-05)	
Rainfall Shocks X Father's occupation				
(a) X (1)	-0.0224	0.0848*	-0.00201	-0.00116
	(0.0223)	(0.0438)	(0.00478)	(0.00482)
(a) X (4)	-0.00635	-0.00561	-0.00872	-0.00525
	(0.00771)	(0.00790)	(0.00774)	(0.00790)
(a) X (5)	0.0253	-0.0237	0.0480	0.0503
	(0.0175)	(0.0242)	(0.0790)	(0.0795)
(a) X (7)	0.0370	-0.00343	-0.000240	0.00223
	(0.0268)	(0.0298)	(0.00699)	(0.00711)
(b) X (1)	-0.0131	-0.00308	-0.0290	-0.0284
	(0.0138)	(0.0141)	(0.0435)	(0.0439)
(b) X (2)	0.0317**	-0.0155	0.0282	0.0328
	(0.0148)	(0.0211)	(0.0600)	(0.0603)
(d) X (3)	0.296	-0.434	0.668	0.646
	(0.284)	(0.377)	(1.106)	(1.117)
(b) X (4)	-0.0194	0.0120	-0.0303	-0.0304
	(0.0132)	(0.0172)	(0.0426)	(0.0429)
(b) X (5)	-0.0243	0.0201	-0.0421	-0.0421
	(0.0164)	(0.0223)	(0.0640)	(0.0645)
(b) X (6)	-0.0200	0.0117	-0.0318	-0.0310
	(0.0127)	(0.0166)	(0.0434)	(0.0438)
(b) X (7)	-0.0434*	0.0118	-0.0340	-0.0335
	(0.0233)	(0.0294)	(0.0454)	(0.0458)
(c) X (1)	0.0602	-0.0875	0.142	0.138
	(0.0723)	(0.0873)	(0.266)	(0.268)
(c) X (2)	0.0935	-0.132	0.194	0.187
	(0.0868)	(0.116)	(0.326)	(0.329)
(c) X (4)	0.0683	-0.122	0.138	0.135
	(0.0719)	(0.0968)	(0.264)	(0.266)

Table 2.7 – Continued

IV	D(Relatives), D(Credit program), D(Savings coop,)	(A) + past rainfall volatility)	(A) + rainfall shocks	(C) + past rainfall volatility
(c) X (5)	0.0810	-0.130	0.165	0.162
	(0.0776)	(0.105)	(0.301)	(0.304)
(c) X (6)	0.0702	-0.122	0.143	0.139
	(0.0718)	(0.0966)	(0.265)	(0.267)
(c) X (7)	0.0607	-0.124	0.136	0.134
	(0.0706)	(0.0946)	(0.263)	(0.266)
(d) X (1)	0.0653*	-0.121*	0.0804	0.0826
	(0.0342)	(0.0732)	(0.125)	(0.126)
(d) X (4)	0.0537**	-0.0256	0.0917	0.0899
	(0.0272)	(0.0370)	(0.130)	(0.131)
(d) X (6)	0.0448	-0.0329	0.0805	0.0842
	(0.0275)	(0.0382)	(0.126)	(0.127)
(d) X (7)	0.0279	-0.0285	0.0851	0.0838
	(0.0314)	(0.0363)	(0.128)	(0.129)
(e) X (1)	-2.96e-05	-4.55e-05	-5.91e-06	-1.88e-05
	(2.85e-05)	(2.91e-05)	(4.62e-05)	(4.68e-05)
(e) X (2)	-1.34e-05	-4.56e-05	-1.09e-05	-1.46e-05
	(2.75e-05)	(2.94e-05)	(4.05e-05)	(4.10e-05)
(e) X (3)	-3.85e-05	-0.000101**	-7.83e-06	-1.14e-05
	(3.97e-05)	(4.49e-05)	(9.68e-05)	(9.79e-05)
(e) X (4)	-3.35e-05	-3.69e-05	-7.66e-06	-2.10e-05
	(2.84e-05)	(2.85e-05)	(4.62e-05)	(4.69e-05)
(e) X (5)	-4.17e-05	-3.10e-05	-2.18e-05	-3.51e-05

Table 2.7 – Continued

IV	D(Relatives), D(Credit program), D(Savings coop,)	(A) + past rainfall volatility)	(A) + rainfall shocks	(C) + past rainfall volatility
	(2.88e-05)	(2.91e-05)	(5.01e-05)	(5.06e-05)
(e) X (6)	-3.39e-05	-3.63e-05	-7.74e-06	-2.01e-05
	(2.84e-05)	(2.85e-05)	(4.64e-05)	(4.70e-05)
(e) X (7)	-3.27e-05	-3.74e-05	-7.87e-06	-2.12e-05
	(2.86e-05)	(2.87e-05)	(4.58e-05)	(4.65e-05)
(f) X (1)	7.48e-06	7.01e-05**	-1.21e-05	-1.55e-05
	(2.53e-05)	(3.30e-05)	(7.29e-05)	(7.33e-05)
(f) X (2)	-2.10e-05	6.86e-05	6.11e-06	-1.76e-05
	(4.44e-05)	(5.27e-05)	(0.000156)	(0.000157)
(h) X (3)	-0.00122	0.00188	-0.00279	-0.00270
	(0.00121)	(0.00160)	(0.00469)	(0.00474)
(f) X (4)	1.64e-05	4.39e-05*	-9.73e-06	-1.26e-05
	(2.43e-05)	(2.57e-05)	(7.45e-05)	(7.49e-05)
(f) X (5)	3.32e-05*	3.46e-05*	1.86e-05	1.58e-05
	(1.97e-05)	(1.96e-05)	(3.47e-05)	(3.49e-05)
(f) X (6)	1.73e-05	4.23e-05	-9.22e-06	-1.40e-05
	(2.45e-05)	(2.58e-05)	(7.35e-05)	(7.40e-05)

Table 2.7 – Continued

IV	D(Relatives), D(Credit program), D(Savings coop,)	(A) + past rainfall volatility)	(A) + rainfall shocks		(C) + past rainfall volatility	
(f) X (7)			1.32e-05	4.72e-05*	-7.50e-06	-1.03e-05
			(2.31e-05)	(2.54e-05)	(7.54e-05)	(7.59e-05)
(g) X (1)			-4.49e-05	-0.000192**	-2.31e-05	-1.66e-05
			(6.58e-05)	(8.80e-05)	(2.46e-05)	(2.50e-05)
(g) X (2)			-0.000480**	0.000148	-0.000550	-0.000518
			(0.000242)	(0.000315)	(0.000685)	(0.000690)
(g) X (4)			-8.76e-05*	-8.34e-06	-1.81e-05	-1.59e-05
			(4.78e-05)	(5.29e-05)	(1.51e-05)	(1.52e-05)
(g) X (5)			-0.000108**	7.76e-06	-5.97e-05	-5.62e-05
			(4.93e-05)	(6.01e-05)	(7.38e-05)	(7.43e-05)
(g) X (6)			-8.77e-05*	-6.11e-06	-2.20e-05*	-1.58e-05
			(4.86e-05)	(5.35e-05)	(1.20e-05)	(1.21e-05)
(h) X (1)			0.000251*	-0.000392		
			(0.000141)	(0.000260)		
(h) X (4)			0.000172*	6.76e-06	3.58e-05	3.36e-05
			(0.000102)	(0.000113)	(2.77e-05)	(2.81e-05)
(h) X (5)			0.000170*	3.25e-06		
			(0.000102)	(0.000113)		
(h) X (6)			0.000160	-9.46e-06		

Table 2.7 – Continued

IV	D(Relatives), D(Credit program), D(Savings coop,)		(A) + past rainfall volatility)		(A) + rainfall shocks		(C) + past rainfall volatility	
					(0.000104)	(0.000115)		
Observations	1,456	1,456	1,456	1,456	1,456	1,456	1,456	1,456
R-squared	0.157	0.212	0.217	0.247	0.245	0.265	0.246	0.265
IV F-stat	9.990	0.442	5.372	2.507	4.293	1.958	3.200	1.859
Individual Covariates	Y	Y	Y	Y	Y	Y	Y	Y
Community FE	N	Y	N	Y	N	Y	N	Y

Notes: 1. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1. 2. Among the category of father's occupation category, "unemployed etc" is dropped.

Table 2.8: IV Estimation of the Effect of Current Liquidity Constraints on Child Test Scores

Specification	(A)		(B)		(C)	
	(1)	(2)	(3)	(4)	(5)	(6)
IV	D(Relatives), D(Credit program), D(Savings coop,)		(A) + past rainfall volatility)		(A) + rainfall shocks	
VARIABLES	PPVT	Math	PPVT	Math	PPVT	Math
Panel A: Younger cohort Round 2						
Liquidity Constraints	-0.536***	-2.117***	-0.181***	-0.953***	-0.175***	-1.008***
	(0.125)	(0.441)	(0.0411)	(0.140)	(0.0367)	(0.128)
Panel B: Older cohort Round 2						
Liquidity Constraints	0.317**	-0.0372	0.115*	0.0399	0.0540	0.0265
	(0.125)	(0.258)	(0.0620)	(0.142)	(0.0522)	(0.121)
Panel C: Younger cohort Round 3						
Liquidity Constraints	-0.985**	1.683**	-0.144	-0.165	0.00152	-0.132
	(0.469)	(0.789)	(0.0968)	(0.142)	(0.0725)	(0.106)
Panel D: Older cohort Round 3						
Liquidity Constraints	-4.387	3.055	0.340***	0.969***	0.0826	0.448**
	(4.770)	(3.808)	(0.128)	(0.262)	(0.0910)	(0.181))
Individual Covariates	Y	Y	Y	Y	Y	Y
Community FE	N	N	N	N	N	N

Notes: 1. Liquidity Constraints variable : 1 equals “Can raise money,” 2 equals “Probably can raise money,” 3 equals “Cannot raise money.” 2. Test scores are standardized. 3. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table 2.9: IV Estimation of the Effect of Early Liquidity Constraints on Later Child Test Score

Specification	(A)		(B)		(C)	
	(1)	(2)	(3)	(4)	(5)	(6)
IV	D(Relatives), D(Credit program), D(Savings coop,)		(A) + past rainfall volatility)		(A) + rainfall shocks	
VARIABLES	PPVT	Math	PPVT	Math	PPVT	Math
Panel A: Younger cohort in Round 3						
Liquidity Constraints in Round 2	-0.0927	-0.265	-0.0115	-0.376***	-0.0481	-0.542***
	(0.136)	(0.201)	(0.0723)	(0.108)	(0.0615)	(0.0955)
Panel B: Older cohort in Round 3						
Liquidity Constraints in Round 2	-0.162	-0.278	-0.00256	0.169	-0.0519	0.149
	(0.135)	(0.265)	(0.0832)	(0.163)	(0.0668)	(0.132)
Individual Covariates	Y	Y	Y	Y	Y	Y
Community FE	N	N	N	N	N	N

Notes: 1. Liquidity Constraints variable : 1 equals "Can raise money," 2 equals "Probably can raise money," 3 equals "Cannot raise money." 2. Test scores are standardized. 3. Standard errors clustered within village in parentheses. *** $p<0.01$.** $p<0.05$. * $p<0.1$.

Chapter 3

The Influence of Licensing Engineers on Their Labor Market

with Morris M. Kleiner[1] *and Yingchun Wang*[2,3]

3.1 Introduction

Analysts of the labor market for engineers have often documented the phenomenon of recurring booms and busts (Hansen, 1961; Folk, 1970; Freeman, 1976). One potential public policy solution has been to regulate the market for engineers, especially ones that require licenses to practice within the occupation and thereby reduce market volatility for engineers. With regulation and planning, perhaps these wide swings, which result in uncertainty for both employers and those considering entering the occupation, could be reduced. Besides the stated public policy rationale that labor market regulation improves public health and safety, it also may serve to reduce fluctuations in the market for engineers. Licensing may

[1]Professor and AFL-CIO Chair, Humphrey School of Pubilc Affairs, University of Minnesota

[2]Assistant Professor, University of Houston Downtown

[3]Yoon Sun Hur, Morris M. Kleiner, and Yingchun Wang contributed equally to this work.

create a web of rules that results in a more orderly functioning of the labor market for the occupation that reduces uncertainty and variance in quality (Dunlop, 1958). Further, engineers and the functioning of their labor markets are viewed as important contributors to innovation and economic growth. An analysis that sheds light on the functioning of these labor markets may contribute to an understanding of how institutional factors influence engineering's contribution to technological change. However, if the influence of licensing for engineers is similar to markets for other regulated occupations, it may then restrict the supply of labor, causing an increase in wages and a reduction in the utilization of engineers in production (Kleiner and Kudrle, 2000; Kleiner and Todd, 2009).

The general policy issue of occupational licensing is an important and growing one in the U.S. labor market, since it is among the fastest-growing labor market institutions in the U.S. economy. For example, in the 1950s about 4.5 percent of the workforce was covered by licensing laws by state government (Kleiner, 2006). By 2008 approximately 29 percent of the U.S. workforce had attained licensing by any level of government, and by the 1990s more than 800 occupations were licensed by at least one state (Brinegar and Schmitt, 1992; Kleiner and Krueger, 2013; Princeton Data Improvement Initiative, 2008). This figure compares with about 12.6 percent of the members of the workforce who said they were union members in the Current Population Survey (CPS) for the same year; that value subsequently decreases 11.3 percent by the end of 2012 (Hirsch and Macpherson, 2011; Bureau of Labor Statistics Database, 2013). Although we do not have information on trends for the licensing of engineers, their level of unionization has declined, which is consistent with national trends. Figure 2.1 shows the decline in unionization for civil, electrical, and industrial engineers from 1983 to 2010. The steepest dip was for electrical engineers, where unionization declined from about 12.2 percent in 1983 to 4.8 percent in 2010. The smallest decline was for industrial engineers, whose rates of unionization declined from 9.2 percent to 8.3 percent over the same time period. We will focus our analysis on these engineering specialties for this chapter since they represent a continuum of more to less regulated specialties in engineering.

Since occupational regulation has many forms, describing its various types is worthwhile. The occupational regulation of engineers in the United States generally takes three forms. The least restrictive form is registration, in which individuals file their names, addresses, and qualifications with a government agency before practicing their occupation. The registration process may include posting a bond or filing a fee. In contrast, certification permits any person to perform the relevant tasks, but the government - or sometimes a private, nonprofit agency - administers an examination or other method to determine qualifications and certifies those who have achieved the level of skill and knowledge for certification. For example, travel agents and car mechanics are generally certified but not licensed. Most restrictive form of regulation is licensure; this form of regulation is often referred to as the right to practice. Under licensure laws, working in an occupation for compensation without first meeting government standards is illegal. Our analysis provides a first look at the role of occupational licensing, rather than the other two forms of governmental regulation in the labor market for engineers in the United States.

We examine the role for occupational licensing in the labor market for engineers from 2000 through 2012. Initially, we present the evolution and anatomy of occupational licensing for engineers. Next, we present a theory of licensing and show how this form of regulation leads to wages dropping to the competitive wage as the licensing authority increases the supply of practitioners. In the following section, we show the data for the analysis and present the growth of regulation for the three types of engineers in our data set. Next, we present our empirical analysis for three large specialties in engineering - civil, electrical, and industrial - when variations in occupational licensing characteristics such as examinations and pass rates are included. In the final section, we summarize our results.

The theoretical model shows that government-granted licenses to protect the public can also lead to rents for the members of the occupation. As more individuals are allowed into the occupation by the planner, wages fall. To the extent that regulation reduces innovation and that unregulated members of the occupation can do higher wage tasks, regulation may diminish wages. The estimates in our models are small for the labor market effects of licensing, and they depend on the requirements and the engineering specialty examined. Also, some evidence indicates that some licensing requirements influence the number of hours worked by engineering specialty. The studies of the influence of licensing statutes on labor market outcomes perhaps need better data on individuals who have a license rather than just state licensing coverage, since coverage biases downward the influence of this type of regulation (Gittleman and Kleiner, 2013). In this study we focus on licensing coverage rather than attainment, since determining attainment is possible only when individual data explicitly ask whether an individual is licensed.

3.2 The Evolution and Anatomy of Licensing for Engineers

Similar to other occupations that eventually became licensed, such as dentists and nurses, the government regulation of engineers began in the early 1900s (Council of State Governments, 2013). The first state to pass a licensure law was Wyoming in 1907. At the time, Wyoming engineers were concerned with water speculators who lacked the qualifications or experience of trained engineers but nonetheless used the term "engineer" The law was passed so that "all the surveying and engineering pertaining to irrigation works should be properly done" (Russell and Stouffer (2003) p.1.) The American Society of Civil Engineers (ASCE) supported this piece of legislation, but otherwise resisted the notion of state-controlled licensing. After 1910, many civil engineering associations supported the concept of state licensing in order to control specific aspects of the practice that would be regulated. The ASCE promulgated a model law for licensure in 1910. This shift in policy also helped the occupation of civil engineering to be consistent with regulations that were being developed in other professions such as medicine and law, which had already accepted licensure (Haber, 1991; Pfatteicher, 1996).

Around 1920, the National Council of State Boards of Engineering Examiners was formed to work for licensure in every state, help enforce regulations, and ensure appropriate levels of experience and education for professional practice. This organization evolved into the National Council of Examiners for Engineering and Surveying (NCEES). As more states adopted regulations for professional practice, these engineering associations also became involved in advocating for the standardization of engineering curricula in professional schools and universities. It took nearly 45 years for all 50 states to require licensure for the practice of civil engineering, although these licenses were required only for certain types of tasks that engineers perform.

In contrast, chemical, electrical, mechanical, and petroleum engineering were recognized as title holders and were covered by licensing following World War II. In the 1960s, industrial engineering was recognized as a title branch and was also regulated. Table 3.1 shows the percentage of engineers licensed by specialty in the United States, according to the National Council of Examiners for Engineering and Surveying (NCEES) in 1995. Civil engineering was by far the most regulated branch of engineering, with more than 44 percent of those practicing being licensed; this percentage was more than twice that of mechanical engineers, the second-most licensed engineering specialty. As the estimates in Table 3.1 show, about 9 percent of the more than 800,000 electrical engineers, the largest category of professional engineers, were licensed in the mid-1990s, and only 8 percent of industrial engineers were licensed. This suggests large variance in the amount of regulation in the occupation of engineering. Moreover, the vast majority of engineers are covered by licensing statutes but do not attain a license.

To measure the level of difficulty that each of the states sets for becoming a professional engineer, we develop an index of restrictiveness of engineer regulation. Not only has the level of licensing increased, but also the intensity of the process of becoming licensed has become more difficult. Based on conversations with key officials at the NCEES, as well as with focus groups comprising engineers, architects, and interior designers, we have identified the following central items as important in becoming licensed: a general age/education requirement, experience requirements, a written exam, a practical performance exam, a specific engineering specialty exam, reciprocity requirements from other states, and a continuing education requirement[4].

These elements are the basis of an index of the rigor of the licensing process, in addition to the type of licensing. Using this index, we can trace the evolution of the intensity of the licensing index in the period 1995 to2012. Table 3.3 summarizes the index of licensing regulations for engineers. The results show a slight upward movement in the mean values and a narrower spread in the variance of the licensing provisions across states. Occupational licensing is growing among states, and its provisions to enter and maintain good standing as a licensed professional engineer are becoming more stringent.

The nation's umbrella engineering licensing body embraced a so-called Model Rule that would extend by 30 the number of extra credit-hours BS-degreed engineers must have to gain a professional license, but no state licensing board has made it a reality. However, the deadline for the professional association is still more than 5 years away in 2020. The goals of the licensing groups are to increase the status of engineers. For example, a former ASCE president and supporter of the increased requirements for becoming a licensed engineer stated the following: "If we want to meet challenges and be prepared to protect the public, engineers need more depth of knowledge," says Blaine Leonard, former ASCE president. "You can't get it in programs under pressure." Proponents would like to see engineering attain the same professional status as medicine and accounting. The National Academy of Engineering and the National Society of Professional Engineers support the idea (Rubin and Rubin, 2012).

[4]We met with officials at the Minnesota Board of Architecture, Engineering, Land Surveying Landscape Architecture, Geoscience and Interior Design (AELSLAGID) regarding key criteria for licensing in that State and with licensed engineers in Minnesota, Arizona and California.

3.3 Theoretical Framework

To provide a theoretical context for our empirical work, we first present a model of the influence of licensing on the supply of labor. In the following section, we focus on the demand for labor and how the government can be an important factor within a licensing model. The analysis of wage determination under licensing in engineering builds on work by Perloff (1980)on the influence of licensing laws on wage changes in the construction industry. The basic model posits that market forces are largely responsible for wage determination and that the demand for work is highly cyclical. This approach would also apply to the engineering labor market. Perloff presents two cases. In the first, there are no costs to shifting across industries so that labor supply is completely elastic at the opportunity wage. In this case, the increase in the demand for work would have little effect on wages, since workers would flow between varying industries. The introduction of a licensing law renders the supply of labor inelastic. In this case, labor cannot flow between the sectors so that variations in demand would be reflected in the wage. In his empirical work, Perloff shows that for electricians, more so than for either laborers or plumbers, state regulations make the supply curve highly inelastic. Consequently, the ability of a state to limit entry or impose major costs on entry through licensing would enhance the occupation's ability to raise wages. We would expect that a similar approach would apply to the market for engineers, with more inelastic supply curves for civil engineers relative to electrical and industrial engineers.

Unlike the work that has been developed on the supply side, relatively little analysis has been done on how degrees of restriction of labor supply with occupational licensing influence engineers' wages and their amount of work, and how such restrictions of supply make the labor market deviate from a competitive market. Our model focuses on the supply restriction of labor, and we develop a general model that we will apply to the regulation of engineers. We develop a model as follows:

Let $Q \equiv \sum_{i=1}^{n} q_i$, where q_i is each engineers work output, n is the number of engineers in the market, and Q is the total quantity of supply. Each engineer's monetary utility function is $U_i = q_i P(Q) - D_i(q_i)$, where D denotes the engineers disutility. The first-order condition for utility maximization of engineer i is $P(Q) - D_i'(q_i) + q_i P'(Q) = 0$.

From the above equation, we have:

$$\frac{P(Q) - D_i'(q_i)}{P} = \frac{\frac{q_i}{Q}}{-\frac{P}{P'(Q)Q}} = \frac{\alpha}{\epsilon} \tag{3.1}$$

where $\alpha = \frac{q_i}{Q}$ is engineer i's market share, and $\epsilon = -\frac{P}{P'(Q)Q}$ is the elasticity of demand. Thus, the gap between price and marginal disutility is proportional to the engineers market share and inversely proportional to the elasticity of demand. Price exceeds the engineers marginal disutility. The larger the difference, the more prices deviate from the socially efficient price.

For instance, for the symmetric case in which every engineer has the same output, with linear demand, $P(Q) = 1 - aQ$ for all i, and the convex disutility function being $D = bq + cq^2$. We assume that a, b, c are greater than zero, so that the demand is inversely related to supply and the disutility is a convex function. The first-order condition of the engineers utility maximization becomes $1 - aQ - b - 2cq_i - aq_1 = 0$. The equilibrium is symmetric for this symmetric model: $Q = nq$, where q is the output per engineer. Hence, we obtain:

$$q = \frac{1 - b}{an + 2c + a} \tag{3.2}$$

The market price is:

$$p = b + \frac{(1 - b)(2c + a)}{an + 2c + a} \tag{3.3}$$

And each engineer's utility is :

$$U = \frac{(1-b)^2(a+c)}{(an+2c+a)^2} \tag{3.4}$$

The number of engineers is an exogenous variable in the model. It is decided by the pass rate for the licensing examination. The stricter the licensing examination, the smaller the n. Equations 3.2 to 3.4 show that when the licensing requirement is stricter, the incumbent engineers wage, output per person (measured as work hours in the empirical section), and utility of the engineer will all increase.

From the above results and Equation 3.1, we have $\frac{P(Q)=D_i'(q_i)}{P} = \frac{\alpha}{\epsilon} = \frac{a(1-b)}{abn+2c+a}$. So another implication of the model is that the fewer the number of engineers, the further the wage will deviate from the socially efficient wage ($p = D(q_i)$). When the number of engineers becomes very large ($n \to \infty$), the wage tends to become the competitive wage.

3.4 Data, Model, and Estimation

Using the above model as our guide, we now present the details of the information on the regulations facing engineers and the labor market conditions of the three broadly representative types of engineers: civil, electrical, and industrial. We chose these types of engineers because they reflect a continuum of regulation ranging from civil engineers who are the most regulated, electrical engineers less so, and industrial engineers the least regulated by state statutes. Table 3.2 displays the key elements (and their operational definition) of the licensing provisions in the statutes and administrative provisions that we plan to examine for each of the states in our sample of engineers.

Table 3.3 shows the yearly growth in the occupational licensing statutes index over the period 1995-2012. The results indicate that the occupation experienced growth in regulations governing entry and training requirements. The level of the index or the number of items included in the measure grew from 6.94 to 7.25, or by about 4 percent. This reflects the intensity of the growth of requirements to enter and maintain the status as a licensed engineer. Further, the standard deviation declined by almost 23 percent, suggesting greater standardization of the requirements for licensing across states over time.

Table 3.4 shows the relative ranking of the states that have the highest and lowest values in the index. We also developed values that were established through an expert systems focus group approach to test the sensitivity of the results to alternative methods of evaluation. In this approach, an engineering student and a law student were given the data and asked to rank the states based on issues that were personally important to them as professionals in their respective fields. There was a high degree of consistency for the empirical and qualitative approaches. For many states, we were able to obtain the pass rates for the licensing examination for engineers. Figure 3.2 shows the states and time trend in years for which we were able to obtain from NCEES the overall engineering pass rates. The plots in the figure show that California has one of the lowest steady-state pass rate for the engineering exam, averaging about 40 percent per year. In contrast, the pass rate for the licensing of engineers in Idaho is well above 80 percent. Unfortunately, no systematic national estimates could be developed because of the state data limitations over time and across states.

3.4.1 Economic Data

As a key part of our examination of the influence of regulation on the labor market for engineers, we use data from the American Community Survey (ACS) from 2001 through 2012. Table 3.5 presents the basic information that we used for our analysis. These variables include the standard variables from the ACS to include Mincer-type human capital variables such as gender, age, experience, education, and race. Unfortunately, no data on union status are available in the ACS. The means and standard deviations for the basic variables in the ACS are included in Table 3.5 by type of engineer. They show that there are small differences in human capital characteristics such as age, experience, or education across engineering specialties. However, the percentage of civil engineers who work for the government (about 24 percent) and are self-employed (about 5 percent) is much higher than in the other two types of engineering subgroups. The hourly earnings of electrical engineers (about $ 37 per hour), are the highest of the three categories. Generally, the licensing requirements for civil engineers have been in force the longest and are the most detailed across states. The estimates for hours worked are also derived from the ACS. Since there are more observations over time for civil engineers, we have information for all states and years for this category. For electrical and industrial engineers, however, some state and year observations are missing in the ACS, so states such as Wyoming, Hawaii, Montana, and South Dakota are missing observations for a couple of years in our sample.

3.4.2 Wage Determination

Our empirical strategy is to first examine the three categories of engineers - civil, electrical, and industrial - that may vary greatly by the type of regulation that influences their ability to find employment. We estimate the model using all engineers in the categories together and then estimate wage equations for each group separately. In Figure 3.3 we show kernel density plots for the three types of engineers in our study. The results show that electrical engineers have the highest mean value for wages and the widest distribution of earnings among the three types of engineers we study, but industrial engineers have the lowest mean value.

Our basic model uses an earnings function and compares the three types of engineers (the least regulated one, industrial engineers, is the excluded category). Our basic model is of the following form:

$$ln(Earnings_{ist}) = \alpha + \beta R_{st} + \gamma X_{ist} + T_{ist} + \delta_s + \theta_t + \epsilon_{ist} \tag{3.5}$$

where $Earnings_{ist}$ is the hourly earnings of engineer i at state s in year t; T_{ist} is the type of engineer (civil, electrical, or industrial) for person is state s in year t; R_{st} is the occupational licensing regulations (and its components) in state s in year t; X_{ist} is the vector that includes covariates measuring characteristics of each person; δ and θ are state and year fixed effects, respectively; and ϵ_{ist} is the error term in our panel data.[5]

The model is a basic fixed effects approach that can also be viewed as a generalization of the conventional two-group two-period difference-in-difference model.[6] The estimates presented in the tables show the estimates for both a traditional panel estimate using individuals as the unit of observation of the role of regulation on wage determination and a two-stage estimation procedure. For the two-stage procedure, the first stage is developed by estimating a model of individual-level outcomes on covariates and a full set of state x X time fixed effects. The coefficients on the state x X time fixed effects represent state x time mean outcomes that have been purged of the variation associated with the within-cell variation in the covariates. In the second stage, these adjusted cell level means are estimates on the policy variables and fixed effects. The two-step approach is a way of performing aggregation while still allowing for adjustment of individual-level covariates, which is a limitation of the pure aggregation.[7] The basic panel estimates include individual covariates as well as state

[5] The error term can be union status and personal preferences etc.

[6] We also included time-varying state-level controls, such as the state median household income, but found that they have no explanatory power. Consequently, we do not show the results in this chapter.

[7] Moulton (1990) criticized the differences-in-differences (DID) type of analysis when the variable of interest (policy variable) is at the aggregate level while the variable in the dependent variable (e.g. wages of workers) is at the individual level. He indicates that this type of DID analysis may cause the problem of clustering that small group level clustering can inflate standard error by large amount. Bertrand, Duflo, and Mullainathan (2004), Donald and Lang (2007), and Conley and Taber (2011) discuss about the possible solutions for the problem. Those scholar have agreed that the cluster robust standard error can work perfectly only when the number of cluster is large enough and there are not many observations within cluster. The proposed solutions from scholars are aggregating the outcome data to cell (e.g. state-year) means and statistical testing based on placebo distribution and randomization inference approach. The aggregation analysis has one difficulties when one want to use covariates that varies within the cells. To deal with this issue, this chapter employs a two level model. The first level is a regression of the dependent variable (wages and hours worked) on covariates and a full set of interactions of state and time fixed effects. The interaction of state and time fixed effect tries to exploit the state-specific trends and the coefficients of

and year fixed effects.[8]

Table 3.6 shows estimates from the model developed from the overall licensing index on wage determination using both the individual observations and the two- level analyses with controls. Since the index is an imprecise measurement of regulation, we develop a relative measure of regulation of high, medium, and low levels of regulation using our index. We then compare the highest levels of regulation relative to the low and medium ones. The first column shows the basic bivariate relationship between having the most restrictive licensing statutes and wage determination with the full sample of the ACS. The basic relationship shows a statistically significant 2 percent effect.[9] However, in the second column when personal characteristics and state specific covariates are included, the estimates are still positive but small and not statistically significant. In examining the various engineering specializations in columns 3 through 8, we can see that there is some variation. For example, the bivariate estimates for civil engineers show a positive but small influence of being in a state with the most stringent regulations in the first stage, but no effect in the second stage. Similarly, for both electrical and industrial engineers, the engineering regulations have a small but positive effect in the first stage bivariate estimates, but no influence in the second stage results. The significant estimates range from a high of 4 percent with no covariates for industrial engineers with no covariates to no effect in the fully specified model. The categorical specifications show regulation for engineers has a small effect that is close to zero. This is not unlike some of the specifications of the influence of unions on wage determination for other professional organizations (Lewis, 1986). Moreover, we have estimates only of licensing coverage and not those who have attained a license, which may bias our results downward (Gittleman and Kleiner, 2013). However, licensing requirements may also have effects on the supply of hours to the market.

these interactions shows the mean outcomes in state and time level that is adjusted to the variations within cell in the individual covariates. In the second stage, these adjusted cell level means are regressed on the policy variables of interest, state fixed effects and time fixed effects and their interactions.

[8]The standard errors for these models were computed using a Huber-White covariance matrix that allowed for clustering at the state level.

[9]We also estimated models that examined the influence of tougher licensing before and after the great recession of 2008, and found results similar to those presented in Tables 3.6, 3.7, 3.9, and 3.10.

The models developed for hours of work use approaches similar to the ones developed for our wage equation models. In a similar manner, we examine employment growth for each of the categories of engineers from 2001 to 2012. The basic model is of the following form:

$$ln(Employment_{ist}) = \alpha + \beta R_{st} + \gamma X_{ist} + T_{ist} + \delta_s + \theta_t + \epsilon_{ist} \tag{3.6}$$

where $Employment_{ist}$ is hours of work per week per engineer in state s in time period t for individual i; R_{st} is the regulation measure and its components at state s in time period t; T_{ist} is the type of engineer at state s in time period t for individual i; the vector X_{st} includes covariates measuring economic and human capital characteristics within each state; δ_s and θ_t are state and year fixed effects, respectively; and ϵ_{ist} is the error term.

Table 3.7 gives the basic results for the impact of the licensing index on hours of work supplied by engineers using the specified model and categorical measures of regulation of high relative to low or medium. The results are consistent in showing that regulation is associated with an increase in hours worked by about 1 percent in the bivariate estimates. The two-level analysis shows similar and more imprecise effect, even though it is not statistically significant. If regulation is effective in restricting the supply of new entrants to some extent, then those in the occupation are likely to work more hours. The results in Table 3.7 are consistent with this hypothesis.

Although the categorical transformation of the overall index does not show much effect on the key labor market variables of wages and hours worked, perhaps several of the individual components of the licensing index may influence wages and hours worked. The use of an examination to determine the impact of this variable on wage determination has been used in other studies (Kleiner and Kudrle, 2000; Kleiner and Krueger, 2013). Through the examination process and the establishment of higher standards, access to and supply of engineers can be reduced, and if demand remains constant, wages can increase. Moreover, the pass rate for the engineering exam may also limit the entry of new engineers and drive up wages and hours for those who do become engineers.

In Table 3.8 we list the states that require a professional exam for each specific type of licensing examination. In order to become licensed, engineers usually take a fundamental or first exam, the basic step toward becoming a licensed engineer. This exam is often administered to engineers just prior to their finishing undergraduate studies. The professional exam, in contrast, covers general engineering practices and is usually given after engineers have been practicing for four or more years. It is the final stage of licensing coverage for entry into the occupation. Table 3.8 shows that Ohio and Arkansas adopted a professional exam in 2002 and 2009, respectively; they serve as basis for a difference-in-difference analysis. The difference-in-difference model is relative to Ohio and Arkansas, which were the states that changed its regulatory statutes for exams over the time period of our analysis.

In order to provide sensitivity analysis for our previous estimates and include the estimates for an additional regulatory requirement, we include whether there is a professional exam requirement to become licensed. Table 3.9 shows the estimates on wage and hours using seemingly unrelated regression (SUR) methods for the influence of having a professional exam requirement as part of the licensing requirement. Since only two states changed the exam requirements during the period under study, we used this method as an additional sensitivity test of our estimates. Panel A shows the results when engineers are categorized by type of engineering field: civil, electrical, and industrial. In Panel B we estimate the model for all the engineers in our sample. Those results are consistent with the general results shown in Table 3.6, 3.7, and 3.8 and show only a small coefficient size for this requirement and varying levels of significance, based on the type of engineering specialty and the labor market outcome variable selected which was hourly wages or hours worked.

In Table 3.11, we examine whether the lagged professional exam requirement variable may have influenced economic factors. Using the lagged professional licensing requirement and current economic data through 2012, the table shows that these results are consistent in displaying a mixed to minor influence on wage determination. At least for licensing coverage, which is what our data allow us to measure, occupational licensing has a small influence on wage determination for civil engineers, but has a mixed influence on other engineering specialties. This may reflect the fact that the attainment of a license matters more with respect to wage determination, rather than the passage of a law regulating an occupation that is largely unregulated by the government (Gittleman and Kleiner, 2013). Even though H. Gregg Lewis finds that being represented by a union raises wages by about 15 percent in aggregate, for many occupations such as hospital workers and well-educated male workers, the influence of unions is either zero or even slightly negative (Lewis, 1986). Similarly, for civil engineers, who are more heavily licensed, tougher regulations may not enhance their earnings, perhaps because unregulated workers are able to be more innovative and create new markets relative to engineers who have their work standardized by the government (Friedman, 1962).

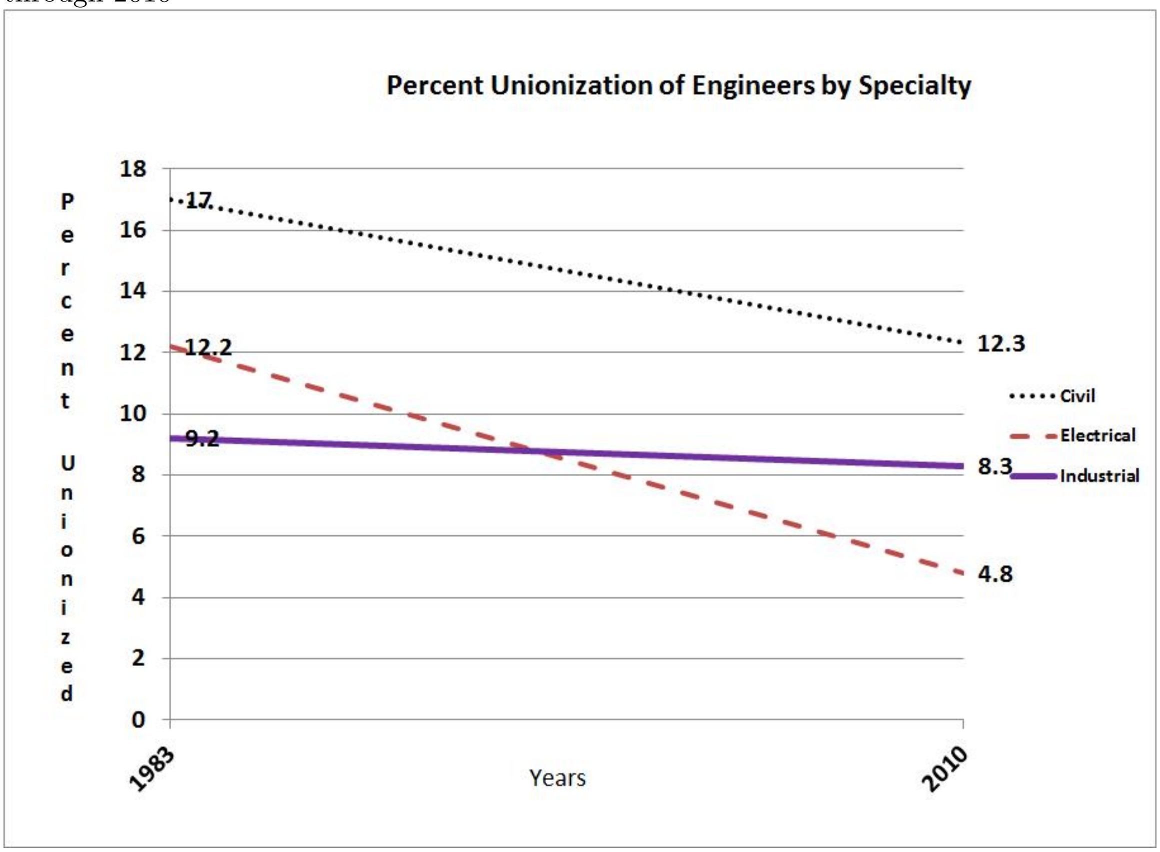
3.5 Conclusion

This chapter presents the first comprehensive analysis of the role of occupational licensing requirements on the labor market for civil, electrical, and industrial engineers. These groups of engineers represent the largest number of engineers that are covered by occupational licensing statutes in the United States. We initially trace the historical evolution of licensing for engineers. Second, we present a theoretical rationale for the role of government in the labor market for the occupation. In the model, the government's ability to control supply through licensing restrictions and the pass rate limits the number of engineers, which drives up wages. These results are useful for informing the empirical models for engineers.

In the empirical section, we show that licensing for these occupations has grown more somewhat more rigorous during the period 2001-2012. We then estimate a panel data model (state level) for the engineers in our sample using the ACS. In the U.S. economy, if engineers achieve the goal of their professional association of more rigid requirements, and a longer time to become an engineer, the growth of regulation of the occupation may reduce customer access to engineers and slow down the ability of builders and manufacturers to use engineering services. Our study provides a first look at these issues. Exploring the potential issue of selection across engineering specialties, and using more detailed analysis such as the use of discontinuities when the passage of more rigorous laws occurs, may provide more refined or precise estimates and examples of the role of regulation in the market for engineers. Further, a more thorough analysis would include individuals who have attained a license rather than licensing coverage, and these data would allow us to obtain a better measure of the influence of occupational licensing on those who chose to get the credential to legally do certain engineering tasks.

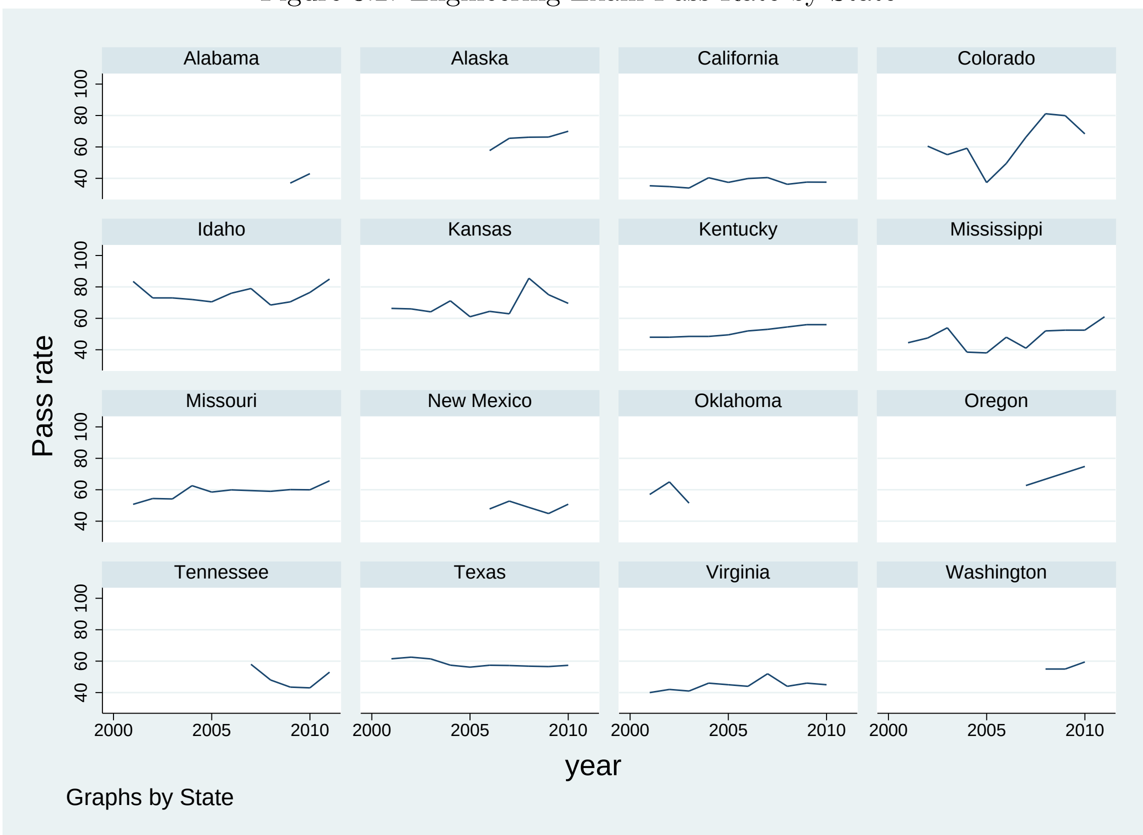
3.6 Figures and Tables

Figure 3.1: Decline in Unionization for Civil, Electrical and Industrial Engineers, 1983 through 2010



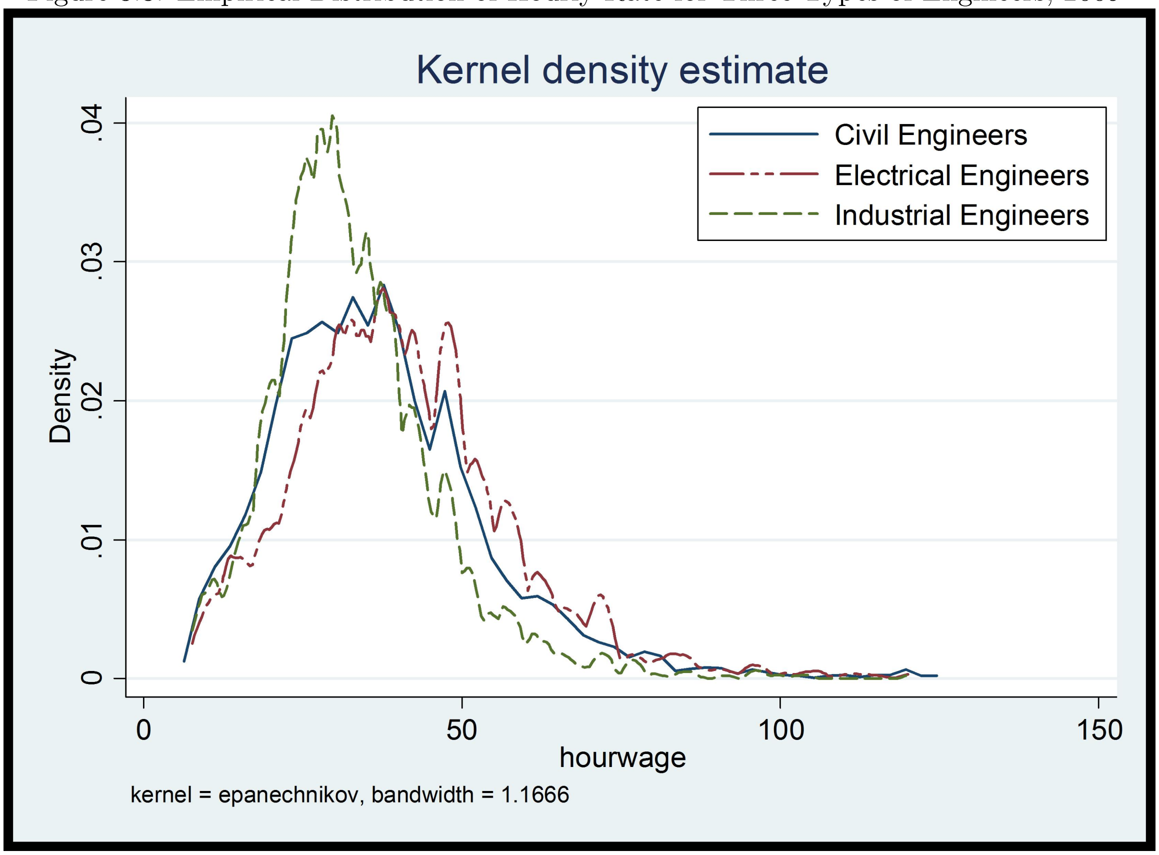
Note: Current Population Survey, various years calculated by the authors.

Figure 3.2: Engineering Exam Pass Rate by State



Source: NCEES

Figure 3.3: Empirical Distribution of Hourly Rate for Three Types of Engineers, 2009



Note: Sample includes those engineers making above the minimum wage and excludes those with greater than the top 1 percent of hourly wage.

Table 3.1: Percentage of Engineers Licensed by Specialty, 1995

Engineering Discipline	Approx. # Engineers	Approx. # Licensed	Percentage Licensed
Civil	360,000	160,000	44
Mechanical	395,000	91,000	23
Electrical	803,000	73,000	9
Chemical	180,000	15,000	8
Industrial	133,000	11,000	8
Agricultural	40,000	5,000	13
Mining and Metals	30,000	5,000	17
Other	259,000	40,000	15
Total	2,200,000	400,000	18

Source: Paul Taylor, NCEES Licensure Bulletin, December 1995

Table 3.2: Key Elements in Development of the Licensing Index for Engineers

Major Components	Definition
Education requirement	3 if minimum level of education required to be licensed is bachelors degree; 2 if it is associates degree; 1 if board decides; otherwise 0
Experience requirement	3 if minimum level of experience required to be licensed is 8 years; 2 if it is 4 years; 1 if it is 2 years; 0 if no requirement
Professional exam requirement	1 if professional exam is required to be licensed; otherwise 0
Fundamental exam requirement	1 if fundamental engineering exam is required; otherwise 0
Interim exam requirement	1 if exam required for interim permit; otherwise 0
Continuing education requirement	1 if state has any requirement for continuing education; otherwise 0
Specific exam requirement	1 if specific additional exam is required for engineering discipline; otherwise 0

Notes: 1. Developed by the authors. 2. The interim permission is for engineer who has a license in a state and wants to get another one in other state.

Table 3.3: Growth of Occupational Licensing Intensity over Time

Year	Mean	Std. Dev.	Min	Max
1995	6.94	2.04	0.00	9.00
1996	6.86	2.03	0.00	9.00
1997	6.89	1.86	0.00	9.00
1998	7.08	1.71	0.00	9.00
1999	7.08	1.71	0.00	9.00
2000	7.06	1.70	0.00	9.00
2001	7.06	1.70	0.00	9.00
2002	7.06	1.70	0.00	9.00
2003	7.06	1.70	0.00	9.00
2004	7.08	1.72	0.00	9.00
2005	7.08	1.72	0.00	9.00
2006	7.08	1.72	0.00	9.00
2007	7.08	1.72	1.00	9.00
2008	7.08	1.72	1.00	9.00
2009	7.08	1.72	1.00	9.00
2010	7.25	1.59	1.00	9.00
2011	7.25	1.59	1.00	9.00
2012	7.25	1.58	1.00	9.00

Note: Index is the summated rating value of the key provisions for licensing engineers as noted in Table 3.2 tabulated by the authors. The Number of State is 51 for each year.

Table 3.4: Regulation Rankings of Top and Bottom States by Restrictiveness of Licensing, 2009

Top States	Index	Bottom States	Index
Pennsylvania	9	Virginia	1
Georgia	9	Minnesota	3
Texas	9	South Dakota	4
Illinois	9	DC	5
Arizona	9	Delaware	5
Colorado	9	Connecticut	5

Note: The higher the index, the more restrictive.

Table 3.5: Key Variables for Engineers in the ACS, 2001-2012

	Civil Engineers		Electrical Engineers		Industrial Engineers	
	Mean	SD	Mean	SD	Mean	SD
Age	43.05	11.27	43.48	10.65	43.76	10.83
Schooling (in Year)	16.00	1.67	16.21	1.66	15.70	1.66
Gender (Male:1; Female:0)	0.74	0.44	0.91	0.28	0.81	0.39
Married (Married:1; Not Married:0)	0.73	0.45	0.76	0.43	0.74	0.44
Experience (in Year)	21.05	11.40	21.28	10.89	22.06	11.11
Experience-Squared	572.88	495.33	571.25	473.94	610.37	492.57
White (White:1; Others:0)	0.84	0.36	0.79	0.41	0.87	0.34
Black (Black:1; Others:0)	0.05	0.22	0.04	0.20	0.04	0.19
Citizen (U.S. Citizen:1; Others:0)	0.95	0.21	0.91	0.29	0.94	0.23
Work for For-Profit (Yes:1; No:0)	0.70	0.64	0.88	0.32	0.93	0.26
Work for Not-for-Profit (Yes:1; No:0)	0.04	0.49	0.02	0.14	0.01	0.11
Work for Government (Yes:1; No:0)	0.24	0.62	0.09	0.28	0.05	0.22
Self-employment (Yes:1; No:0)	0.05	0.49	0.01	0.12	0.01	0.08
Hourly Earnings (in 2009 dollars)	34.61	21.20	37.47	18.41	30.35	14.72

Source: American Community Survey

Table 3.6: Influence of Statutory Rank Index on Wage Determination: high relative to medium and low

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	One level	Two level	One level	Two level	One level	Two level	One level	Two level
Sample	All	All	Civil	Civil	Electrical	Electrical	Industrial	Industrial
Highest rank	0.024***	0.007	0.013***	-0.008	0.023***	0.026	0.042***	-0.014
	(0.000)	(0.016)	(0.001)	(0.023)	(0.001)	(0.028)	(0.001)	(0.034)
Observations	7,231,650	612	3,404,866	612	2,300,115	605	1,526,669	580
R-squared	0.000	0.852	0.000	0.715	0.000	0.706	0.000	0.580
Basic control	NO	YES	NO	YES	NO	YES	NO	YES
Year fixed	NO	YES	NO	YES	NO	YES	NO	YES
State fixed	NO	YES	NO	YES	NO	YES	NO	YES

Note: Estimated with age, schooling in years, gender, marital status, experience, experience-squared, race, U.S. citizenship, for profit sector, and self-employment. Two stage regressions are weighted by the number of engineers. The second-stage estimates are aggregate state-level estimates of hours worked calculated from the predicted hours worked individual model, which are then aggregated to the state level. The ACS sample uses individuals who earn less than 250 USD per hour and who are college graduates. Standard errors are in parentheses. ***$p<0.01$, **$p<0.05$, *$p<0.1$

Table 3.7: Influence of Statutory Rank Index on Hours Worked: high relative to medium and low

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	One level	Two level	One level	Two level	One level	Two level	One level	Two level
Sample	All	All	Civil	Civil	Electrical	Electrical	Industrial	Industrial
Highest rank	0.010***	0.009	0.010***	0.010	0.015***	0.012	0.005***	0.008
	(0.000)	(0.006)	(0.000)	(0.008)	(0.000)	(0.009)	(0.000)	(0.011)
Observations	7,231,650	612	3,404,866	612	2,300,115	605	1,526,669	580
R-squared	0.001	0.335	0.001	0.202	0.002	0.216	0.000	0.196
Basic control	NO	YES	NO	YES	NO	YES	NO	YES
Year fixed	NO	YES	NO	YES	NO	YES	NO	YES
State fixed	NO	YES	NO	YES	NO	YES	NO	YES

Note: Estimated with age, schooling in years, gender, marital status, experience, experience-squared, race, U.S. citizenship, for profit sector, and self-employment. Two stage regressions are weighted by the number of engineers. The second-stage estimates are aggregate state-level estimates of hours worked calculated from the predicted hours worked individual model, which are then aggregated to the state level. The ACS sample uses individuals who earn less than 250 USD per hour and who are college graduates. Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1

Table 3.8: State Professional Exam Requirements for Licensure of Engineers

Professional Exam Required	No Professional Exam Required	Changer (year of change)
Alabama	Hawaii	Ohio (2002)
Alaska	Missouri	Arkansas (2009)
Arizona	New Hampshire	
California	New Jersey	
Colorado	New Mexico	
Connecticut	Oregon	
Delaware	South Dakota	
District of Columbia	Utah	
Florida	Virginia	
Georgia	Washington	
Idaho	Wisconsin	
Illinois	Wyoming	
Indiana		
Iowa		
Kansas		
Kentucky		
Louisiana		
Maine		
Maryland		
Massachusetts		
Michigan		
Minnesota		
Mississippi		
Montana		
Nebraska		
Nevada		
New York		
North Carolina		
North Dakota		
Oklahoma		
Pennsylvania		
Rhode Island		
South Carolina		
Tennessee		
Texas		
Vermont		
West Virginia		

Table 3.9: Effect of a Professional Exam on Wage and Hours Worked Using Seemingly Unrelated Regressions: Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Sample	Civil Engineers				Electrical Engineers				Industrial Engineers			
	One level		Two level		One level		Two level		One level		Two level	
Variable	Log of wage	Log of hours	Log of wage	Log of hours	Log of wage	Log of hours	Log of wage	Log of hours	Log of wage	Log of hours	Log of wage	Log of hours
Professional Exam	-0.002***	0.003	-0.146***	-0.057***	0.008***	0.042	0.012	-0.025***	-0.001**	-0.143**	-0.002	0.456
	(0.001)	(0.000)	(0.048)	(0.017)	(0.001)	(0.000)	(0.060)	(0.020)	(0.001)	(0.000)	(0.071)	(0.023)
Observations	3,404,866	3,404,866	612	612	2,300,115	2,300,115	605	605	1,526,669	1,526,669	580	580
R-squared	0.000	0.000	0.719	0.219	0.000	0.000	0.706	0.206	0.000	0.000	0.583	0.168
Basic control	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES
Year fixed	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES
State fixed	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES

Table 3.10: Panel B: Effect on Wage Using SUR for All Engineers

	(1)	(2)	(3)	(4)
	One level		Two level	
Variable	Log of wage	Log of hours worked	Log of wage	Log of hours
Professional Exam	-0.006***	0.004***	-0.107***	-0.022*
	(0.000)	(0.000)	(0.034)	(0.012)
Constant	3.446***	3.760***	3.571***	3.775***
	(0.000)	(0.000)	(0.039)	(0.013)
Observations	7,231,650	7,231,650	612	612
R-squared 0.000	0.000	0.854	0.303	
Basic control	NO	NO	YES	YES
Year fixed	NO	NO	YES	YES
State fixed	NO	NO	YES	YES

Note: Panels A and B were estimated with age, schooling in years, gender, marital status, experience, experience-squared, race, U.S. citizenship, for profit sector, and self-employment. Two stage regressions are weighted by the number of engineers. The second-stage estimates are aggregate state-level estimates of hours worked calculated from the predicted hours worked individual model, which are then aggregated to the state level. The ACS sample uses individuals who earn less than 250 USD per hour and who are college graduates. Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1.

Table 3.11: Influence of Lagged Professional Exam on Wages and Hours Worked (Years 2001-2012)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	One level	Two level	One level	Two level	One level	Two level	One level	Two level
Sample	All	All	Civil	Civil	Electrical	Electrical	Industrial	Industrial
Panel A: Dependent is log of hourly wage								
Lag Professional Exam	0.000	-0.076**	0.003***	-0.066	0.008***	-0.004	-0.016***	-0.128**
	(0.000)	(0.030)	(0.001)	(0.043)	(0.001)	(0.053)	(0.001)	(0.063)
Constant	3.440***	3.564***	3.433***	3.558***	3.515***	3.589***	3.343***	3.493***
	(0.000)	(0.036)	(0.001)	(0.052)	(0.001)	(0.064)	(0.001)	(0.076)
Obs.	7,231,650	612	3,404,866	612	2,300,115	605	1,526,669	580
R-squared	0.000	0.853	0.000	0.716	0.000	0.706	0.000	0.583
Panel B: Dependent is log of hours worked								
Lag PE	0.004***	-0.011	0.003***	-0.037**	0.007***	0.024	-0.001***	-0.010
	(0.000)	(0.010)	(0.000)	(0.016)	(0.000)	(0.018)	(0.000)	(0.021)
Constant	3.761***	3.763***	3.756***	3.772***	3.754***	3.717***	3.782***	3.807***
	(0.000)	(0.012)	(0.000)	(0.019)	(0.000)	(0.021)	(0.000)	(0.025)
Obs.	7,231,650	612	3,404,866	612	2,300,115	605	1,526,669	580
R-squared	0.000	0.300	0.000	0.213	0.000	0.211	0.000	0.168
Basic control	NO	YES	NO	YES	NO	YES	NO	YES
Year fixed	NO	YES	NO	YES	NO	YES	NO	YES
State fixed	NO	YES	NO	YES	NO	YES	NO	YES

Note: Estimated with age, schooling in years, gender, marital status, experience, experience-squared, race, U.S. citizenship, for profit sector, and self-employment. Two stage regressions are weighted by the number of engineers. The second-stage estimates are aggregate state-level estimates of hours worked calculated from the predicted hours worked individual model, which are then aggregated to the state level. The ACS sample uses individuals who earn less than 250 USD per hour and who are college graduates. Standard errors are in parentheses. ***$p<0.01$, **$p<0.05$, *$p<0.1$

Chapter 4

Effect of Liquidity Constraints on Children's Non-cognitive Skills in Vietnam

4.1 Introduction

Parents invest in their children's human capital in several ways. They can buy quality textbooks, provide appropriate nutrition, and send their children to extracurricular classes. Besides these material forms of support, parents can also give emotional support to enhance their children's human capital. Liquidity constraints may determine parents' investments; parents without liquidity constraints can invest in the optimal level of their children's human capital accumulation. Income shocks caused by events such as severe weather and unemployment may lead to liquidity constraints among parents, and so may affect parents' investments in their children's human capital including cognitive and non-cognitive skills

(Becker, 1975; Flug, Spilimbergo, and Wachtenheim, 1998).[1]

Many scholars have examined the link between liquidity constraints and human capital accumulation. Most of the studies, however, both theoretically and empirically, measure the effect of liquidity constraints on schooling and cognitive skills, such as academic performance (Becker and Tomes, 1986; Jacoby and Skoufias, 1997; Caucutt and Lochner, 2012). Relatively less attention has been paid to the link between liquidity constraints and non-cognitive skills.

A relatively new literature emphasizes the role of non-cognitive skills in schooling, labor market outcomes, and even development. Empirical evidence suggests that non-cognitive skills have a significant effect on education and labor market outcomes (Heckman and Rubinstein, 2001; Heckman, Stixrud, and Urzua, 2006; Almlund et al., 2011; Glewwe, Huang, and Park, 2014). Ray (2006) states that poverty and failure of aspirations are closely linked, since dream and the process of attaining dreams, which are related to aspiration, may be hindered by poverty. Dalton, Ghosal, and Mani (2015) explain, using a theoretical model, that low aspirations is a consequence of poverty. Their model indicates that raising aspirations can lead to poverty reduction without the relief of material constraints. Glewwe, Ross, and Wydick (2013) explain that 'external constraints' and 'internal constraints' are both important in human capital accumulation. 'External constraints' can be defined as barriers of access to school or health services, while 'internal constraints' are related to a loss of hopeful feelings, low aspirations, low self-efficacy, and low self-esteem. Glewwe, Ross, and Wydick (2013) show that child sponsorship programs have a positive effect on the relief of internal constraints, leading to higher self-esteem and self-expectations.

Despite evidence emphasizing the importance of non-cognitive skills, and the effect of liquidity constraints on human capital accumulation, few things are known about the link

[1]There are many terms used by scholars to indicate child's emotional development. Psychologists and sociologists have used the term as "socio-emotional development" (e.g. Smilansky and Shefatya (1990)), while economists have widely used "non-cognitive skills" (e.g. Heckman and Rubinstein (2001)). This study uses "non-cognitive skills" to indicate child' socio-emotional development, such as self-esteem, self-efficacy, and aspirations.

between liquidity constraints and non-cognitive skills.[2] McLoyd (1998) discusses in theoretical terms that explains the mediating variables of how parents' economic difficulties affect their child's socio-emotional outcomes. For example, harsh parenting, inconsistent parenting, and discrete and chronic stressors from financial risks may negatively affect a child's non-cognitive skills. However, if parents can reduce their liquidity constraints and thus borrow money, their dysphoria, harsh attitudes, and stress may decrease, reducing the probability that their child's non-cognitive skills are affected by their temporary economic difficulties. However, few empirical studies have estimated the effect of liquidity constraints on non-cognitive skills.

This chapter empirically estimates the effect of parents' liquidity constraints on children's non-cognitive skills in Vietnam. The Young Lives household survey for Vietnam provides unique data that measure children's non-cognitive skills, such as self-esteem, self-efficacy, and aspirations. It also collected information on households' liquidity constraints. To estimate the causal effect of liquidity constraints on a child's non-cognitive skills, this study uses direct measurements of liquidity constraints, whereas most studies on the effect of liquidity constraints have measured those effects indirectly by estimating the effects of income shocks.[3]

The Young Lives household survey data for Vietnam were collected for two cohorts, a younger cohort born in 2001–2002 and an older cohort born in 1994–1995. Both cohorts were surveyed over three rounds (2002, 2006 and 2009).[4] Using these data, this study will estimate the effect of parents' liquidity constraints on children's non-cognitive skills at different ages. In addition, this study also examines to whether the timing of liquidity constraints matters. Similar to cognitive skills, non-cognitive skills begin to develop at an early age (Cunha and Heckman, 2007, 2010). Using the panel data collected using the

[2]Some studies have examined the determinants of non-cognitive skills other than liquidity constraints. For example, Howard (2011) presents evidence that food provided at home can affect a child's non-cognitive skills.

[3]For more details on former literature on liquidity constraints see first chapter of this thesis.

[4]A fourth round was collected in 2013, but is yet publicly available.

Young Lives household survey questionnaires for Vietnam, this chapter also measures the effect of liquidity constraints that occur when child is young on the child's non-cognitive skill at a later age.

This study accounts for the endogenous nature of liquidity constraints. OLS estimates may yield biased and inconsistent estimates when liquidity constraints are endogenous: the liquidity constraints variables may be correlated with the error term. There may be unobserved variables that affect children's non-cognitive skills and are also correlated with liquidity constraints. For example, parents' ambition may affect the likelihood of parents getting access to credit and also directly affect their children's cognitive skills. This chapter will use instrumental variable methods to address bias due to endogeneity. The instrumental variables exploit information about the financial environment faced by household, such as the existence of credit institutions and relatives in the community. These instruments affect the liquidity constraints that households face but do not directly affect children's non-cognitive skills. Other instrumental variables used in this chapter are past rainfall volatility and current rainfall shocks in the community, which capture the inherent riskiness of agricultural income. Past rainfall volatility and current rainfall shocks are unlikely to directly affect the children's non-cognitive skills.

This chapter proceeds as follows. Section 4.2 develops a analytical framework that relates parents' liquidity constraints to children's non-cognitive skills. Section 4.3 describes the main data sets, including the Young Lives household survey data and rainfall data for Vietnam, and Section 4.4 develops the empirical specification. The estimation results are presented in Section 4.5. Finally, Section 4.6 summarizes the results and discusses policy implications.

4.2 Analytical Framework

This section provides a simple analytical framework to measure the effect of liquidity constraints on children's non-cognitive skills during early and late childhood.

Let HC_t denote a child's human capital when the child is t years old. The children's human capital formation function is:

$$HC_t = f_t(L_t, H_t, X_t, \epsilon_t) \tag{4.1}$$

where L_t denotes the households' liquidity constraints when the child is t years old, H_t is household characteristics, such as income, father's education, mother's education, household size, rural or urban residence, and religion of mother. X_t is the child's characteristics, such as gender, age, and an indicator for being a first born child, and ϵ_t is the error term. The error term represents the unobserved characteristics and preferences for human capital investment, such as the parents' ambition.

This chapter allows for the possibility that a household's liquidity constraints when the child is t years old are endogenous. It means that the liquidity constraints variable can be correlated with the error term, which includes the unobserved characteristics and preferences for human capital investment. For example, the more ambitious parents are the less probability that the parents are liquidity constrained and the more likely that they invest in child's human capital. To avoid the bias from the endogenous liquidity constraints, this study uses instrumental variables such as the existence of subsidized credit program in the community, CP_t, the existence of savings cooperative in the community, SC_t, the existence of relatives in community, REL_t, past rainfall volatility in the community, RV, and current rainfall shocks in the community, RS_t. The following specification presents the first stage of equation for instrumental variable estimation of equation (4.1):

$$L_t = f_t^L(CP_t, SC_t, REL_t, RV, RS_t, H_t, X_t, \epsilon_t^L) \tag{4.2}$$

To obtain an understanding of the effect of liquidity constraints on children's non-cognitive skills at different stages of childhood, this study will check whether the effect is different at different ages.

4.3 Data

4.3.1 Young Lives Household Survey Data for Vietnam

The Young Lives household survey data for Vietnam were used to collect information on child and household characteristics of 3,000 children. These children are divided into two group: 1,000 older cohort children born in 1994–95, and 2,000 younger cohort children born in 2000–01. The data have been collected over three rounds: Round 1 in 2002, Round 2 in 2006, and Round 3 in 2009.

The younger cohort children were about 1 year old in 2002 (Round 1), 4–5 years old in 2006 (Round 2), and 7–8 years old in 2009 (Round 3). The older cohort children were 7-8 years old in 2002 (Round 1), 11–12 years old in 2006 (Round 2), and 14–15 years old in 2009 (Round 3). To see the effect of liquidity constraints on children's non-cognitive skills at different child ages, this chapter conducts separate analyses by cohort and round. The younger cohort children in Round 2 were too young to measure their non-cognitive skills, and the non-cognitive skills data were not collected in Round 1. Therefore this study excludes the younger cohort in Rounds 1 and 2 from the analysis. Thus this chapter examines three sub-samples: the older cohort in Rounds 2 and 3, and the younger cohort in Round 3.

This study excludes children who have no data on non-cognitive skills, or who are missing selected household and child characteristics. Compared to Chapter 2 of this thesis, which estimated the effect of liquidity constraints on children's cognitive skills, this chapter includes fewer children in the analysis because of missing data for the non-cognitive skills variable. About half of the children are dropped because of the missing data in the non-cognitive skills. This study also excludes older cohort children who do not appear in at least one of two rounds (Rounds 2 and 3), or who have missing data on individual and household characteristics. The final numbers of children by cohort and round, which vary by cohort, round and the non-cognitive skills variable, are shown in Table 4.1. Note that aspirations was not measured for the younger cohort in Round 3. The self-esteem is measured for older cohort in Round 3, but this variable missing for most of the sample, so this study includes only self-efficacy and aspirations for the older cohort in Round 3.

Table 4.1: Number of Observations and Child Age by Sub-samples

	Round 2 (2006)	Round 3 (2009)
Younger cohorts		835(Self-esteem), 871(Self-efficacy)
(born 2001-2)		7-8 yrs
Older cohorts	752(Self-esteem, self-efficacy, aspiration)	674(Self-efficacy), 809(Aspiration)
(born 1994-5)	11-12 yrs	14-15 yrs

4.3.2 Measurement of Non-cognitive Skills

Following Dercon and Sanchez (2011), this chapter measures children's non-cognitive skills in three dimensions: self-esteem, self-efficacy and aspirations.

Table 4.2 shows the questions used to measure children's non-cognitive skills in the Young Lives household questionnaires for Vietnam. There are several questions for measuring self-esteem and self-efficacy. Following Glewwe, Ross, and Wydick (2013) and Dercon and Sanchez (2011), this chapter uses summary indices (averages) of these questions. Glewwe, Ross, and Wydick (2013) indicate that there is a potential problem when using each question as a measure of non-cognitive skill and running separate regressions. There is a possibility that some variables show "significant" impacts even though the real impact is zero, when a large number of regressions are estimated for large number of dependent variables. Using the summary index in the regressing will help avoid this problem.

The total score for self-esteem is calculated by the average of the eight questions about how the child feels about his or her life. A child can choose one of the following answers for each question: strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree. I code the answers so that strongly disagree is coded as 1, disagree is coded as 2, neither agree nor disagree is coded as 3, agree is coded as 4, and strongly agree is coded as 5.[5] Thus the higher the score, the higher the self-esteem. These questions are based on the Rosenberg Self-Esteem Scale (Dercon and Sanchez, 2011).[6]

To measure self-efficacy, the Young Lives household questionnaire for Vietnam contains questions on whether the child thinks that he (or she) can control his (or her) life by himself (or herself) and whether he (or she) trusts that his (or her) effort will be rewarded in the future. The negative question is recorded so that higher values indicate a higher self-efficacy level. The total score of self-efficacy is calculated by the average of the five questions.

Aspirations can be measured by asking whether children can set a goal (Dercon and Sanchez, 2011; Quaglia and Cobb, 1996). The Young Lives household questionnaires for Vietnam ask children about the level of formal education that the child wants to complete if there were no constraints, so that he or she could stay at school as long as he or she likes. The children can answer with the year and level of the education they want to achieve. This chapter coded one to twelve for the education until the high school, fourteen to the technical or pedagogical institution, sixteen to the bachelor degree, and nineteen to the master or doctoral degree.

[5]In Round 2, the child could choose among four answers: strongly disagree, disagree, agree, and strongly agree. This chapter coded strongly disagree as 1, disagree as 2, agree as 3, and strongly agree as 4 in Round 2.

[6]Dercon and Sanchez (2011) include nine questions to measure self-esteem. This chapter, however, excludes, the question “I feel embarrassed by the work I have to do”, because of missing data for many children.

Table 4.2: Questions Measuring Non-cognitive Skills in the Young Lives Data for Vietnam

Question	Mean	SD	Min	Max
Self-esteem	3.73	0.43	2.38	5.00
I feel proud to show where I live	3.57	0.94	1.00	5.00
I am proud of my clothes	3.52	0.86	1.00	5.00
I feel proud of the job done by household head	3.87	0.86	1.00	5.00
I am proud because I have the right books, pencils etc	3.50	1.17	1.00	5.00
I am proud of the work I have to do	3.47	1.11	1.00	5.00
I am proud of my shoes	3.84	0.83	1.00	5.00
I am proud that I have the correct uniform	4.19	0.67	1.00	5.00
The job I do makes me feel proud	3.79	0.80	1.00	5.00
Self efficacy	3.69	0.40	2.20	4.80
If I try hard I can improve my situation in life	4.14	0.65	1.00	5.00
Other people in my family make all the decisions about how I spend my time	2.60	0.99	1.00	5.00
I like to make plans for my future studies and work	4.07	0.70	1.00	5.00
I have a choice about the work I do	2.87	1.05	1.00	5.00
If I study hard, I will be rewarded by a better job in the future	4.39	0.61	1.00	5.00
Aspirations				
Imagine you had no constraints and could stay at school as long as you like. What level of formal education would you like to complete?	14.72	2.67	0.00	19.00

Notes: 1. The summary statistics in this table is for older cohort in Round 3 (Self-efficacy and aspirations) and younger cohort in Round 3 (Self-esteem). 2. This table only reports summary indices calculated by the average of relevant questions. For the summary statistics for the total of relevant question, see Table 4.3.

4.3.3 Measurement of Liquidity Constraints

A liquidity constrained household can be defined as a household that cannot obtain the amount of cash it needs and also can paid back (Jappelli, 1990). The sources of cash are various, such as savings, assets, and loans.

Following the definition of Jappelli (1990), this chapter classifies a household as liquidity constrained if it answers "No" to following question[7]

- Question 1: Would your household be able to raise 300,000 VND (in Round 3, for Round 2 the figure was 230,000 VND) in one week if you needed it?[8]
  Answers : Yes / Probably / No

4.3.4 Rainfall Data

The other main source of data for the analysis in this study is rainfall data, including the past rainfall volatility and current rainfall shocks. For more details about the rainfall data, please see Chapter 2.

[7] For more explanation of the definition of a liquidity constrained household, please see Chapter 2.
[8] 300,000 VND in 2009 was about 16.25 in 2009 USD. 230,000 VND in 2006 is about 14.94 in 2006 USD. Vietnam's GDP per capita in 2009 was 1,232 USD, and 797 USD in 2006. (Econstat.com)

4.4 Methodology

4.4.1 Measuring the Effect of Liquidity Constraints on Children's Non-cognitive Skills using Ordinary Least Squares Analysis

To measure the effect of liquidity credit constraints on children's non-cognitive skills, this chapter will estimate the following equation:

$$y_{i,h,c,t} = \alpha L_{h,c,t} + \sum_{i=1}^{I} \beta_i X_{i,h,c,t} + \tau_c + \varepsilon_{i,h,c,t} \tag{4.3}$$

where $y_{i,h,c,t}$ is the non-cognitive skills of child i from household h in community c when the child is t years old. $L_{h,c,t}$ is originally a categorical variable that equals one when the household "can raise the money", equals two when the household "probably can raise the money", and equals three when the households "cannot raise the money." This studies uses dummy variables of each category in the empirical specification. The X_i variables are the characteristics of the child and his or her household, such as sex, mother's education, father's education, mother's religion, household income, rural or urban residence, and household size, and the child's BMI (weight over height squared) when he or she was first surveyed (when the younger cohort was 6 to 19 months old and the older cohort was 7–8 years old). The variable τ_c allows for community-specific fixed effects and $\varepsilon_{i,h,c,t}$ is an error term.

This chapter also estimates the effect of liquidity constraints in Round 2 on children's non-cognitive skills 3 years later. The specification is as follows:

$$y_{i,h,c,t} = \alpha L_{h,c,t-1} + \sum_{i=1}^{I} \beta_i X_{i,h,c,t} + \tau_c + \varepsilon_{i,h,c,t} \tag{4.4}$$

where $L_{h,c,t-1}$ is the liquidity constraints variable in the previous round.

4.4.2 Measuring the Effect of Liquidity Constraints on Child's Non-cognitive Skills using Two Stage Least Squares Analysis

OLS estimates of equations (4.3) and (4.4) may be biased and inconsistent when the liquidity constraints are endogenous. That is, the liquidity constraints may be correlated with the error terms in equations (4.3) and (4.4), in which case the OLS estimates will be biased and inconsistent. To deal with the potential bias, this chapter instruments the liquidity constraint variable. This chapter uses the existence of a credit union in the community, the existence of a savings cooperatives in the community, the existence of relatives in the community, and the volatility and shock of rainfall as instrumental variables.[9] The effect of the rainfall variables may depend on the occupation of household head. So the rainfall volatility and rainfall shocks variables interact with father's occupation. Using these instrumental variables, the first stage equation is as follows:

$$L_{h,c,t} = \gamma CP_{c,t} + \kappa SC_{i,c,t} + \delta REL_{i,h,c,t} + \epsilon RV_c + RS_{c,t} + \sum_{i=1}^{I} \theta_i X_{i,h,c,t} + \zeta_c + \varepsilon_{i,h,c,t} \quad (4.5)$$

where $CP_{c,t}$ is a dummy variable of the existence of credit program, $SC_{c,t}$ is a dummy variable of the existence of savings cooperative, $REL_{h,c,t}$ is a dummy variable of the existence of relatives in community, RV_c is the past rainfall volatility from 1979 to 1993, and $RS_{c,t}$ is current rainfall shocks. To allow the effect of the rainfall variables to vary by occupation, this study use interaction term of rain fall variables and father's occupation. The occupation variable is a categorical variable with seven categorical values: self-employed in the agricultural sector, wage-employed in the agricultural sector, other in the agricultural sector, self-employed in the non-agricultural sector, wage-employed in the non-agricultural sector, other in the non-agricultural sector, and unemployed.[10]

[9]The community level variables are used only when the community fixed effects is not included in the equation (4.3) and (4.4).
[10]For the validity of these instrumental variables, please see Chapter 2.

4.5 Results

Table 4.3 presents summary statistics of non-cognitive skills and other individual covariates by the status of liquidity constraints. Some noticeable patterns are that there are differences in the non-cognitive skills by liquidity constraint status. The children from the non-liquidity constrained household have higher self-esteem and self-efficacy and expect more education than children from the liquidity constrained household.

The analysis below uses the standardized scores of the summary indices (average score of relevant questions). Only the results using the standardized scores of indices are reported in the following section.

4.5.1 OLS Estimates of the Effect of Current Liquidity Constraints on Children's Non-cognitive Skills

Table 4.4 presents OLS results of the effect of liquidity constraints on children's non-cognitive skills in Round 3 for the younger cohort. Each column is from estimating equation (4.3), controlling for only the individual covariates (columns 1 and 3), and controlling for individual covariates plus community fixed effects (columns 2 and 4). The dependent variables are all standardized scores of the summary indices calculated by the average of relevant questions. Standard errors are clustered at the community level. The younger cohort children were 7-8 years old at that time.

The OLS results in Table 4.4 suggest that a high degree of liquidity constraints lowers children's self-esteem by 0.589 standard deviations (Column 2). As seen in column 4 of Table 4.4, children from the households who "probably can raise money" tend to have lower levels (0.238 standard deviations) of self-efficacy compared to children from non-liquidity constrained households. There is no significant effect of liquidity constraints when households answer that they “cannot raise the money.” It may be because of large standard error and small number of households who answer “cannot” (Column 4 in Table 4.4).[11] This chapter conducts a Hausman test, checking the null-hypothesis that there is no systematic difference between coefficient of “probably” and that of “cannot.” The P-value is 0.19 for Column 4 in Table 4.4, so one can not reject the null-hypothesis. It indicates that liquidity constraints has negative effect on children’s self-esteem and aspirations when they were 7–8 years old.

Tables 4.5 and Table 4.6 present the empirical analysis about the relationship between parents’ liquidity constraints and older cohort’s non-cognitive skills when the older cohort was 11–12 years and 14–15 years old, respectively. One interesting to notice is that there is positive effect of “probably can raise” on children’s aspirations (Column 6 in Table 4.5). Even though there is no statistically significant effect of “cannot raise” in Column 6, the Hausman test tell us that one cannot reject the null-hypothesis that two coefficients are identical (P-value is 0.7). There are also negative effect of liquidity constraints on children’s self-esteem and self-efficacy (Column 2 and 4 in Table 4.5), when they were 11–12 years old. The result in Table 4.5 indicates that liquidity constraints have mixed effect on children’s non-cognitive skills for older cohort.

In Round 3, older cohort children from the households that answer “probably” has lower self-efficacy than children from household who can raise the money by 0.156 standard deviations (Column 2 in Table 4.6). Again the Hausman test checking the difference between two coefficients of liquidity constraints variables in Column 2 indicates that one cannot reject the null -hypothesis. It means that there is negative effect of liquidity constraints on children’s self-efficacy when children were 14–15 years old.

Similar to the results from Chapter 2, which estimated the effect of liquidity constraints on children’s school performance, the OLS results indicate that liquidity constraints have

[11] About 4 percent of total household (36 out of 871) answer that the household “cannot” raise the money. For more details about the proportion of household by the status of liquidity constraint, please see Table 4.3.

severe negative effects on a child's non cognitive skills. The size of effect is larger for younger cohort (0.2–0.6 standard deviations) than for older cohorts (0.2–0.4 standard deviations). There is mixed effect of liquidity constraints when children were 11–12 years old. This results suggest that a child's non-cognitive skills may be determined in the early stage of life. When the child is young, their non-cognitive skills are in the process of formation and may be sensitive to parent's financial constraints. When child ages 11–12 or older, his or her non-cognitive skills may not be sensitively affected by parent's financial constraints anymore.

4.5.2 OLS Estimates of the Effect of Liquidity Constraints in Round 2 on Children's Non-cognitive Skills in Round 3

The dynamic effect of liquidity constraints is more severe for younger cohort (equation 4.4). Tables 4.7 and 4.8 present the effect of liquidity constraints in Round 2 on children's non-cognitive skills in Round 3 for the younger and older cohorts, respectively.

The liquidity constraints in the previous round (Round 2) lower children's self-esteem and in Round 3 by 0.406 standard deviations for the younger cohort (Columns 2 in Table 4.7). This result indicates that the liquidity constraints when children were 4–5 years old have a negative effect on their self-esteem when they were 7–8 years old. The Hausman test comparing coefficients of "probably" and "cannot" indicates that there is no systematic difference between two coefficients. It means that there is negative effect of liquidity constraints on children's self-efficacy three years after.

The negative effect of liquidity constraints in the previous round is also shown for older cohort, but the size of effect is relatively smaller than that for younger cohort and the significance level is low. Table 4.8 shows that there is negative effect from the liquidity constraints on children's self-esteem by 0.266 standard deviations in next round. The significance level is only 10 percent, however.

This chapter also runs same regression but including the liquidity constraints in Round 2 and Round 3 at the same time. The result is reported in the Appendix C (Table C1 and C2). Table C1 indicates that liquidity constraints when the child was 4–5 years old have a negative effect on child' non-cognitive skills when the child was 7–8 years old (0.1–0.3 standard deviations). However, as seen in Table C2, liquidity constraints three years ago does not have significant effect when the child was 14–15 years old.

4.5.3 IV Estimates of the Effect of Liquidity Constraints on Children's Non-cognitive Skills

While the OLS results are often statistically significant, they may be biased. To address this bias, this chapter estimates equation (4.5) using instrumental variables. The first stage result indicates that F-statistics are between 5–12, which indicates that the instrumental variable is not unusually weak.[12]

Table 4.9 presents IV estimates of the liquidity constraints effect on child's non-cognitive skills in the same round. Specification A includes a dummy for relatives, a dummy for credit programs, and a dummy for savings cooperatives as instrumental variables. Specification B includes all instrumental variables in Specification A plus past rainfall volatility, and Specification C includes all instrumental variables in Specification A plus current rainfall shocks. Specification C indicates that liquidity constraints lower younger cohort children's self-efficacy by 0.047 standard deviations. However, this chapter cannot observe any negative effect from children's non-cognitive skills when they were 11-12 years old and 14–15 years old. There are some positive effect for older cohort in Round 2: liquidity constraints has positive effect on older cohort's aspirations (Column 3 and 6). But the significance level is only 10 percent.

[12] As discussed in Chapter 2, the critical value of F-statistics to avoid biased result is five (Stock and Yogo, 2005). For more about the discussion on the first stage of IV estimates, please see Chapter 2.

Table 4.10 presents the effect of liquidity constraints on children's non-cognitive skills in the next round. The results are similar to those of OLS for older cohort: the liquidity constraints when child was 11–12 years old does not have any effect on child's non-cognitive skills 3 years after, while there is some negative effect of liquidity constraints when child was 4–5 years old on child's non cognitive skills when child was 7–8 years old (Column 8).

One interesting result in Table 4.10 is that the liquidity constraints in Round 2 has significant and positive effect on older cohort's self-efficacy. We can observe that liquidity constraints when a child was 11–12 years old have positive effect on child's self-efficacy measured when the child was 14–15 years old by 0.694 standard deviations (Column 2). This result may refer to the critical time of non-cognitive skills formation. The liquidity constraints may be "out of date" for older cohort when they are in adolescent stage of life. Another possible explanation is that children's tough time when they were 11–12 years old due to liquidity constraints may have positive effect on their non-cognitive skills and "build" their characteristics more stronger.

4.6 Conclusion

This study examines the linkage between parents' liquidity constraints and children's non-cognitive skills. Most of the studies measuring the effect of liquidity constraints have focused on the "external constraints" and have measured how the liquidity constraints lower children's access to school, good tutors, quality books, etc. This study focuses on the relationship between "external constraints" and "internal constraints" by measuring how liquidity constraints affect children's feelings and emotions.

The empirical result indicates that parents' liquidity constraints have negative and significant effects on children's self-esteem and self-efficacy when the child is in a young age

(7–8 years old). Both OLS and IV estimation indicate that the effect is mixed when the child is older (11–12 years old and 14–15 years old).

The link between parents' liquidity constraints and children's non-cognitive skills can have important implications for policy makers in developing countries. As education has been considered a top priority for development, policy makers have implemented many educational policies such as subsidies and loans. The primary goal of these policies is to support families with financial difficulties and increase children's access to school and a high quality education. The results of this chapter indicate that releasing the parents' external constraints may reduce children's internal constraints by increasing their non-cognitive skills, especially for young children.

This study suggests that when supporting families with difficulty, releasing external constraints may be important to enhance both children's cognitive and non-cognitive skills. Also, because the effect of liquidity constraints is more severe for younger children, support for families with young children is needed. There are several education policies that support secondary-school-aged students or college-aged students. There are relatively few subsidies for families with young children. Considering that non-cognitive skills are mostly developed and affected by the environment when a child is in the earliest stages of life, policies for younger students (pre-school and the early years of elementary school), such as subsidies or credit program, are needed. Such policies can include enhancing public education for younger children and also financial and emotional support for families with difficulties.

4.6.1 Tables

Table 4.3: Summary Statistics of Non-cognitive Skills

	All		Liquidty=1		Liquidty=2		Liquidty=3	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Younger Cohort in Round 3								
No. of observation (self-efficacy)	871		361		474		36	
Self-esteem (Mean)	3.73	0.43	3.85	0.39	3.67	0.44	3.52	0.55
Self-efficacy (Mean)	3.60	0.35	3.64	0.37	3.56	0.31	3.63	0.46
Age in months	97.00	3.73	96.89	3.60	97.05	3.78	97.38	4.21
Female	0.52	0.50	0.53	0.50	0.51	0.50	0.50	0.51
Mother's education (yrs)	6.54	3.73	7.63	3.43	6.06	3.73	3.33	3.15
Father's education (yrs)	7.29	3.74	8.37	3.53	6.76	3.70	4.85	3.38
Mother's religion is catholic	0.01	0.12	0.01	0.11	0.02	0.13	0.00	0.00
_ buddism	0.04	0.19	0.05	0.22	0.03	0.17	0.00	0.00
_ protestant	0.01	0.09	0.00	0.07	0.01	0.11	0.00	0.00
_ Cao Dai	0.01	0.10	0.01	0.08	0.01	0.10	0.04	0.21
_none	0.93	0.26	0.92	0.26	0.92	0.26	0.96	0.21
_ Hoa Hao	0.00	0.03	0.00	0.00	0.00	0.04	0.00	0.00
Household size	4.72	1.52	4.73	1.63	4.70	1.45	5.02	1.53
Live in Rural	0.86	0.35	0.84	0.36	0.87	0.34	0.83	0.38
BMI	16.06	1.41	16.17	1.42	16.01	1.40	15.70	1.26
Value of assets (mil)	0.33	3.27	0.72	5.26	0.10	0.48	0.04	0.10
Older Cohort in Round 2								
No. of observation (All variables)	752		403		266		83	
Self-esteem (Mean)	3.48	0.43	3.52	0.43	3.43	0.42	3.39	0.51
Self-efficacy (Mean)	1.55	0.37	1.53	0.36	1.57	0.37	1.57	0.41
Aspirations	13.43	1.26	13.58	1.01	13.38	1.41	12.82	1.70
Age in months	147.49	4.08	147.77	3.97	147.40	4.20	146.40	4.08
Female	0.50	0.50	0.51	0.50	0.49	0.50	0.47	0.50
Mother's education (yrs)	6.79	3.74	7.70	3.59	6.07	3.64	4.41	3.23
Father's education (yrs)	7.73	3.79	8.78	3.52	6.99	3.68	4.64	3.23
Mother's religion is catholic	0.02	0.14	0.02	0.15	0.01	0.12	0.01	0.12
_ buddism	0.04	0.19	0.02	0.15	0.07	0.25	0.03	0.17
_ protestant	0.01	0.09	0.00	0.00	0.02	0.14	0.01	0.12

Table 4.3 – Continued

	All		Liquidity=1		Liquidity=2		Liquidity=3	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
_ Cao Dai	0.01	0.10	0.01	0.08	0.01	0.10	0.03	0.17
_none	0.92	0.26	0.95	0.23	0.89	0.31	0.91	0.28
_ Hoa Hao	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Household size	4.96	1.39	4.83	1.23	5.07	1.55	5.29	1.52
Live in Rural	0.81	0.39	0.84	0.37	0.77	0.42	0.81	0.39
BMI	14.23	1.29	14.17	1.26	14.28	1.34	14.36	1.25
Total income (VND)	17,141	21,770	21,028	23,065	13,707	21,210	8,051	8,301
Older Cohort in Round 3								
No. of observation (aspirations)	809		342		419		48	
Self-efficacy (Mean)	3.69	0.40	3.75	0.38	3.64	0.40	3.78	0.51
Aspirations	14.72	2.67	15.05	2.58	14.50	2.73	14.39	2.45
Age in months	181.08	3.87	181.10	3.87	181.13	3.92	180.35	3.10
Female	0.50	0.50	0.50	0.50	0.51	0.50	0.32	0.48
Mother's education (yrs)	6.75	3.75	7.98	3.43	6.01	3.77	4.68	2.84
Father's education (yrs)	7.69	3.80	8.85	3.75	6.93	3.66	6.36	3.14
Mother's religion is catholic	0.02	0.14	0.03	0.17	0.01	0.11	0.00	0.00
_ buddism	0.04	0.19	0.04	0.19	0.04	0.20	0.00	0.00
_ protestant	0.01	0.10	0.01	0.09	0.01	0.11	0.00	0.00
_ Cao Dai	0.01	0.10	0.01	0.11	0.01	0.09	0.00	0.00
_ none	0.92	0.27	0.91	0.28	0.93	0.26	1.00	0.00
_ Hoa Hao	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Household size	4.96	1.38	4.91	1.30	4.99	1.43	5.00	1.49
Live in Rural	0.81	0.39	0.82	0.38	0.82	0.38	0.68	0.48
BMI	14.23	1.28	14.19	1.20	14.27	1.37	14.14	0.87
Value of assets (mil)	0.53	4.78	1.20	7.44	0.07	0.26	0.03	0.04

Notes: 1. Indices of self-esteem and self-efficacy are not standardized in this table. 2. "Liquidiyt=1" means that the household answers "Yes, I can raise the money", "Liquidiyt=2" means that the household answers "Probably I can raise the money", "Liquidiyt=3" means that the household answers "No, I can't raise the money"

Table 4.4: OLS Estimation of Effect of Liquidity Constraints on Children's Non-cognitive Skills in Round 3 (Younger cohort)

VARIABLES	(1) Self-esteem	(2) Self-esteem	(3) Self-efficacy	(4) Self-efficacy
Liquidity Constraints				
Probably can raise	-0.348***	-0.339***	-0.247**	-0.238**
	(0.0875)	(0.0813)	(0.0948)	(0.0942)
Can not raise	-0.594*	-0.589***	-0.0809	-0.0190
	(0.334)	(0.138)	(0.165)	(0.171)
Individual Covariates				
age in months	-0.00661	0.0101	0.0112	0.0187*
	(0.0107)	(0.00974)	(0.00673)	(0.00950)
gender of yl child	-0.121	-0.0818	-0.0472	-0.0481
	(0.0722)	(0.0779)	(0.0701)	(0.0749)
Mother's education (yrs)	0.0128	0.00932	-0.00380	0.00178
	(0.0216)	(0.0161)	(0.0115)	(0.0128)
Father's education (yrs)	0.0290*	0.0412***	-0.00484	0.00534
	(0.0171)	(0.0141)	(0.0124)	(0.0138)
Mother's religion is catholic	0.925***	0.667***	-0.00233	-0.153
	(0.296)	(0.201)	(0.256)	(0.248)
_ buddism	0.461***	0.312*	-0.133	-0.222*
	(0.144)	(0.157)	(0.182)	(0.127)
_ protestant	0.669*	0.630*	0.747*	0.381
	(0.355)	(0.323)	(0.375)	(0.460)
_ Cao Dai	1.336***	0.686***	-0.290	-0.328
	(0.333)	(0.143)	(0.294)	(0.278)
_none	0.394***	0.410***	-0.122	-0.236***
	(0.0679)	(0.0646)	(0.0815)	(0.0515)
Household size	0.0136	0.0220	-0.00361	-0.00182
	(0.0344)	(0.0323)	(0.0264)	(0.0279)
Live in rural	0.536***	0.0135	0.477***	0.269***
	(0.126)	(0.113)	(0.163)	(0.0875)
BMI	-0.0113	-0.00450	0.0298	0.0184
	(0.0227)	(0.0240)	(0.0268)	(0.0257)
Value of assets (mil)	-0.00891	-0.0204	-0.0149	-0.0170
	(0.0239)	(0.0205)	(0.0252)	(0.0252)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	835	835	871	871
R-squared	0.085	0.260	0.049	0.127

Notes: 1. Self-esteem and self-efficacy are calculated by the average of answers of relevant questions. The summary indices are standardized. 2. Liquidity Constraints : "Can raise 300,000 VND" is the omitted category. 3. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table 4.5: OLS Estimation of Effect of Liquidity Constraints on Children's Non-cognitive Skills in Round 2 (Older cohort)

VARIABLES	(1) Self-esteem	(2) Self-esteem	(3) Self-efficacy	(4) Self-efficacy	(5) Aspirations	(6) Aspirations
Liquidity Constraints						
Probably can raise	-0.0867	-0.0763	0.134*	0.0813	0.102	0.138**
	(0.0913)	(0.0948)	(0.0788)	(0.0654)	(0.0614)	(0.0660)
Cannot raise	-0.251	-0.278	-0.00930	-0.0273	0.137	0.139
	(0.197)	(0.224)	(0.141)	(0.128)	(0.158)	(0.165)
Individual Covariates						
Age in months	0.0167	0.0167	0.00612	0.00908	0.0129	0.00777
	(0.0105)	(0.0102)	(0.00943)	(0.00973)	(0.0113)	(0.0107)
Female	-0.0568	-0.0745	-0.161**	-0.103	-0.122	-0.113
	(0.0691)	(0.0696)	(0.0680)	(0.0802)	(0.0808)	(0.0869)
Mother's education (yrs)	0.0119	0.0224	0.0399***	0.0397***	0.0586***	0.0468***
	(0.0120)	(0.0137)	(0.0111)	(0.0112)	(0.0119)	(0.0122)
Father's education (yrs)	0.0331**	0.0344**	-0.0508***	-0.0445***	0.0549***	0.0496***
	(0.0131)	(0.0137)	(0.00966)	(0.00893)	(0.0116)	(0.0116)
Mother's religion is catholic	0.0622	0.0698	0.244	0.179	0.185	0.0775
	(0.0955)	(0.0877)	(0.219)	(0.254)	(0.145)	(0.135)
_ buddism	-0.259	-0.166	-0.0297	-0.0568	-0.172	-0.220
	(0.169)	(0.200)	(0.104)	(0.116)	(0.153)	(0.164)
_ protestant	-0.0918	0.111	-0.137	0.118	0.472*	0.330
	(0.429)	(0.378)	(0.363)	(0.342)	(0.251)	(0.245)
_ Cao Dai	-0.321	-0.105	0.475	0.354	0.141	-0.167
	(0.259)	(0.335)	(0.607)	(0.683)	(0.548)	(0.577)
Household size	-0.00496	0.0184	0.0790***	0.0712***	-0.0382	-0.00609
	(0.0346)	(0.0376)	(0.0260)	(0.0249)	(0.0431)	(0.0291)
Live in rural	0.139	0.0567	0.183	-0.116	0.0308	1.190**
	(0.0927)	(0.418)	(0.111)	(0.209)	(0.0845)	(0.501)
BMI	0.0523*	0.0499*	0.00751	0.00189	-0.00762	0.00789
	(0.0276)	(0.0290)	(0.0198)	(0.0234)	(0.0306)	(0.0284)
Total income (mil. VND)	3.184*	1.934	3.172	2.020	0.627	0.214
	(1.638)	(1.421)	(2.170)	(2.395)	(1.078)	(1.242)

Individual Covariates	Y	Y	Y	Y	Y	Y
Community FE	N	Y	N	Y	N	Y
Observations	752	752	752	752	752	752
R-squared	0.068	0.148	0.056	0.147	0.127	0.203

Notes: 1. Self-esteem and self-efficacy are calculated by the average of answers of relevant questions. The summary indices are standardized. 2. Liquidity Constraints : “Can raise 230,000 VND” is the omitted category. 3. Standard errors clustered within village in parentheses. *** $p<0.01$.** $p<0.05$. * $p<0.1$.

Table 4.6: OLS Estimation of Effect of Liquidity Constraints on Children's Non-cognitive Skills in Round 3 (Older cohort)

VARIABLES	(1) Self-efficacy	(2) Self-efficacy	(3) Aspirations	(4) Aspirations
Liquidity Constraints				
Probably can raise	-0.170**	-0.156*	-0.0314	0.00651
	(0.0789)	(0.0903)	(0.205)	(0.208)
Cannot raise	-0.137	-0.156	-0.309	-0.364
	(0.235)	(0.260)	(0.355)	(0.373)
Individual Covariates				
Age in months	-0.0108	-0.00481	-0.0425	-0.0325
	(0.0133)	(0.0150)	(0.0262)	(0.0248)
Female	-0.117	-0.132	-0.735***	-0.649***
	(0.0804)	(0.0902)	(0.136)	(0.129)
Mother's education (yrs)	0.0264	0.0161	0.115***	0.0903**
	(0.0170)	(0.0143)	(0.0363)	(0.0330)
Father's education (yrs)	0.00876	0.0134	0.118***	0.135***
	(0.0155)	(0.0161)	(0.0340)	(0.0309)
Mother's religion is catholic	-0.0341	0.115	-1.404*	-2.270***
	(0.849)	(0.718)	(0.814)	(0.576)
_ buddism	-0.683	-0.572	-1.716***	-2.372***
	(0.797)	(0.700)	(0.340)	(0.591)
_ protestant	-0.407	-0.534	-2.034**	-2.551***
	(0.854)	(0.769)	(0.862)	(0.782)
_ Cao Dai	-0.619	-0.365	-3.623*	-4.752**
	(0.934)	(0.840)	(2.095)	(2.290)
_none	-0.541	-0.331	-1.780***	-2.340***
	(0.849)	(0.720)	(0.341)	(0.369)
Household size	0.0373	0.0537	-0.246***	-0.194**
	(0.0314)	(0.0342)	(0.0835)	(0.0826)
Live in Rural	-0.0647	0.635	-0.185	1.276*
	(0.0835)	(0.475)	(0.161)	(0.731)
BMI	-0.00165	-0.00788	0.00401	0.0155
	(0.0375)	(0.0392)	(0.0699)	(0.0683)
Value of assets (mil)	0.00222	-0.00111	-0.0305***	-0.0288***
	(0.00430)	(0.00353)	(0.00611)	(0.00506)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	674	674	809	809
R-squared	0.037	0.093	0.165	0.215

Notes: 1. Self-efficacy are calculated by the average of answers of relevant questions. The summary indices are standardized. 2. Liquidity Constraints : "Can raise 300,000 VND" is the omitted category. 3. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table 4.7: OLS Estimation of Effect of Liquidity Constraints (Round 2) on Children's Non-cognitive Skills in Later stage (Round 3) for Younger Cohort

VARIABLES (Round 3)	(1) Self-esteem	(2) Self-esteem	(3) Self-efficacy	(4) Self-efficacy
Liquidity Constraints				
Probably can raise in Round 2	-0.0908	-0.209***	-0.246***	-0.209**
	(0.0818)	(0.0692)	(0.0829)	(0.0973)
Cannot raise in Round 2	-0.257*	-0.406**	-0.113	-0.151
	(0.142)	(0.151)	(0.138)	(0.141)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	835	835	872	872
R-squared	0.061	0.251	0.049	0.126

Notes: 1. Self-esteem and self-efficacy are calculated by the average of answers of relevant questions. The summary indices are standardized. 2. Liquidity Constraints : "Can raise 300,000 VND" is the omitted category. 3. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table 4.8: OLS Estimation of Effect of Liquidity Constraints (Round 2) on Children's Non-cognitive Skills in Later Stage (Round 3) for Older Cohort

VARIABLES	(1) Self-efficacy	(2) Self-efficacy	(3) Aspiration	(4) Aspiration
Liquidity Constraints				
Probably can raise in Round 2	-0.000950	-0.0175	0.225	0.305
	(0.0675)	(0.0805)	(0.225)	(0.239)
Cannot raise in Round 2	-0.241*	-0.266*	0.139	0.301
	(0.120)	(0.132)	(0.337)	(0.353)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	674	674	809	809
R-squared	0.036	0.096	0.170	0.216

Notes: 1. Self-esteem and self-efficacy are calculated by the average of answers of relevant questions. The summary indices are standardized. 2. Liquidity Constraints : "Can raise 300,000 VND (230,000 VND for Round 2)" is the omitted category. 3. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table 4.9: IV Estimation of the Effect of Current Liquidity Constraints on Children's Non-cognitive Skills

Specification	(A)			(B)			(C)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IV	D(Relatives), D(Credit program), D(Savings coop,)			(A) + past rainfall volatility)			(A) + rainfall shocks		
VARIABLES	Self-esteem	Self-efficacy	Aspiration	Self-esteem	Self-efficacy	Aspiration	Self-esteem	Self-efficacy	Aspiration
	Panel A: Younger cohort Round 3								
Liquidity Constraints	-0.994	-3.657		0.465	-0.246		-0.113	-0.471***	
	(0.912)	(2.415)		(0.257)	(0.245)		(0.170)	(0.162)	
	Panel B: Older cohort Round 2								
Liquidity Constraints	-0.360	0.264	0.674*	-0.176	0.109	0.334*	-0.115	0.0784	0.0420
	(0.293)	(0.282)	(0.365)	(0.157)	(0.157)	(0.196)	(0.135)	(0.134)	(0.163)
	Panel C: Older cohort Round 3								
Liquidity Constraints		-1.361	9.515		-0.199	0.811		-0.307	0.104
		(2.234)	(12.68)		(0.291)	(0.581)		(0.219)	(0.430)
Individual Covariates	Y	Y	Y	Y	Y	Y	Y	Y	Y
Community FE	N	N	N	N	N	N	N	N	N
First Stage F-stat	9.631	9.886	9.438	4.969	4.981	4.867	4.700	4.867	4.943

Notes: 1. Self-esteem and self-efficacy are calculated by the average of answers of relevant questions. The summary indices are standardized. 2. Liquidity Constraints variable : 1 equals "Can raise money," 2 equals "Probably can raise money," 3 equals "Cannot raise money." 3. Standard errors clustered within village in parentheses. *** $p<0.01$.** $p<0.05$. * $p<0.1$. 4. First stage F-statistics are for older cohorts Round 2.

Table 4.10: IV Estimation of the Effect of Current Liquidity Constraints in Round 2 on Children's Non-cognitive Skills in Round 3

Specification	(A)			(B)			(C)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IV	D(Relatives), D(Credit program), D(Savings coop,)			(A) + past rainfall volatility)			(A) + rainfall shocks		
VARIABLES	Self-esteem	Self-efficacy	Aspiration	Self-esteem	Self-efficacy	Aspiration	Self-esteem	Self-efficacy	Aspiration
Panel A: Younger cohort									
Liquidity Constraints in Round 2	0.278	-0.104		0.188	-0.223		0.180	-0.301**	
	(0.277)	(0.263)		(0.168)	(0.145)		(0.148)	(0.128)	
Panel B: Older cohort									
Liquidity Constraints in Round 2		0.694**	0.849		0.255	0.163		0.149	-0.0303
		(0.320)	(0.648)		(0.181)	(0.371)		(0.157)	(0.320)
Individual Covariates	Y	Y	Y	Y	Y	Y	Y	Y	Y
Community FE	N	N	N	N	N	N	N	N	N

Notes: 1. Self-esteem and self-efficacy are calculated by the average of answers of relevant questions. The summary indices are standardized. 2. Liquidity Constraints variable : 1 equals "Can raise money," 2 equals "Probably can raise money," 3 equals "Cannot raise money." 3. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Chapter 5

Conclusion

Chapter 2 and Chapter 4 of this dissertation present the results of empirical analysis that measures the effect of parents' liquidity constraints on children's cognitive and non-cognitive skills. The results contribute to current discussions concerning the effect of liquidity constraints on investments in human capital, especially for young children in the early stage of life, in the context of developing countries. Chapter 4 also contributes to the rapid growth of knowledge on how and when children's non-cognitive skills are developed.

Chapter 2 shows that parents' liquidity constraints have significant negative effects on children's cognitive skills. The size of effect is larger when the child is in his or her early stage of life (4–5 years old and 7–8 years old). To control for potential bias due to the endogeneity of liquidity constraints, this chapter instruments the liquidity constraints with past rainfall volatility, current rainfall shocks, and the existence in the community of subsidized credit programs, of savings cooperatives, and of relatives. Both the OLS and IV analysis support that the liquidity constraints of parents are more severe for young children.

Chapter 4 shows the result of measuring the effect of parents' liquidity constraints on children's non-cognitive skills such as self-esteem, self-efficacy, and aspirations. Similar to the result on children's cognitive skills, the OLS results show that the liquidity constraints of parents lower the children's non-cognitive skills when children are young (7–8 years old). However, the liquidity constraints have mixed effect on children's non-cognitive skills when they are older (11–12 years old and 14–15 years old). One interesting result is the dynamic effect, measuring the effect of liquidity constraints on non-cognitive skills three years later. Chapter 4 found that liquidity constraints that occurred when children were 4–5 years old lowered their non-cognitive skills when they were 7–8 years old. This result is consistent with other literature, which emphasizes the importance of early investment in children's human capital accumulation (e.g., Heckman (2000) and Brooks-Gunn and Duncan (1997)).

These results have policy implications for developing countries. As education is one of the top priorities for developing countries, policy-makers have tried to enhance the quantity and quality of public education by increasing government spending on the public costs. As a result of these effort, education in developing countries has been dramatically enhanced in the past decade. The primary school enrollment rate (gross) for developing countries was 100.9 percent in 2012 (UNESCO, 2015). However, there are still gaps in pre-primary school enrollment between developed and developing countries: the gross enrollment rate in pre-primary school was only 48.8 percent for developing countries, while it was 86.3 percent for developed countries in 2012.[1] This indicates that there are many children behind in education when they are pre-school age in developing countries.

The empirical results in Chapters 2 and 4 also show that children's human capital is more affected when they are younger (4–5 years old and 7–8 years old). There are relative small or insignificant effect form parent's liquidity constraints on children's human capita when they are older (11–12 years old or older). This means that children in the school are less affected by parents' liquidity constraints. Their human capital may be affected by school and teacher characteristics. In case of non-cognitive skills, it may also possible that non-cognitive skills are formulated in the early stage of life and not sensitive to parent's

[1]In Vietnam, the gross rate of enrollment in primary school was 104 percent, while the enrollment rate in pre-primary school is 77 percent in 2012 (UNESCO, 2015).

liquidity constraints anymore when children are older. The policy implication of these two essays is that the policy-makers should consider subsidies for families with liquidity constraints to enhance children's human capital.

Chapter 3, entitled "The Influence of Licensing Engineers on their Labor Market," provides a first look at the effect of regulation on the working hours and wage of engineers. The more rigid the requirements to get the license and the longer time to become an engineer, the further that working hours of engineers increases and ultimately customer access to engineers is reduced, while there is no significant effect on engineers' wage. Occupational licensing, which is one of the fastest-growing labor market institutions, has recently attracted the attention of many scholars. This chapter contributes to the growing literature on the effect of occupational licensing on the labor market.

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Appendix A

Table A1: IV Estimation of Effect of Liquidity Constraints on Child Test Score in Round 2 using Fake IV

	Younger Cohorts		Older Cohorts	
IV: Fake IV	(1)	(2)	(3)	(4)
VARIABLES	PPVT	CDA	PPVT	Math
Liquidity Constraints	0.868	0.426	-1.068	0.843
	(0.929)	(1.459)	(14.07)	(18.66)
Observations	1,456	1,456	812	812
IV F-stat	1.168	1.168	0.00751	0.00751

Notes: 1. Liquidity Constraints variable : 1 equals "Can raise money", 2 equals "Probably can raise money", 3 equals "Cannot raise money". 2. Test scores are standardized. 3. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table A2: OLS Estimation of Effect of Early Liquidity constraints (Round 2) on Child Test Score (Round 3) by cohort, dropping Liquidity constraints in Round 3

VARIABLES	(1) PPVT	(2) PPVT	(3) Math	(4) Math
Panel A: Younger Cohort				
Probably can raise in Round 2	-0.0190	-0.0288	-0.121**	-0.0700
	(0.0382)	(0.0297)	(0.0567)	(0.0485)
Cannot raise in Round 2	-0.0833	-0.0600	-0.195**	-0.0818
	(0.0555)	(0.0458)	(0.0952)	(0.0855)
Observations	1,456	1,456	1,456	1,456
R-squared	0.284	0.390	0.306	0.405
Panel B: Older Cohort				
Probably can raise in Round 2	0.00240	0.0507	0.0436	0.0322
	(0.0414)	(0.0378)	(0.108)	(0.110)
Cannot raise in Round 2	-0.188**	-0.0693	-0.120	-0.156
	(0.0884)	(0.0684)	(0.173)	(0.138)
Observations	812	812	812	812
R-squared	0.228	0.439	0.223	0.351
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y

Notes: 1. Liquidity Constraints : "Can raise 230,000 VND" is the omitted category. 2. Test scores are standardized. 3.Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1. 4. Individual covariates are: age, gender, mother's education, father's education, mother's religion, household size, a dummy for living in Rural, BMI, and household income.

Appendix B

Table B1: Influence of Pass Rates on Wage Determination of Engineers

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	One level	Two level	One level	Two level	One level	Two level	One level	Two level
Sample	All	All	Civil	Civil	Electrical	Electrical	Industrial	Industrial
PE*Passrate	-0.008***	0.000	-0.005***	0.001	-0.013***	0.000	-0.006***	0.000
	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)	(0.002)	(0.000)	(0.001)
PE	0.452***	-0.040	0.251***	-0.044	0.744***	-0.027	0.320***	-0.066
	(0.005)	(0.048)	(0.007)	(0.092)	(0.008)	(0.096)	(0.011)	(0.074)
Passrate	0.004***	-0.001	0.002***	-0.001	0.008***	-0.000	0.003***	-0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Constant	3.210***	3.345***	3.340***	3.307***	3.051***	3.418***	3.156***	3.295***
	(0.005)	(0.040)	(0.007)	(0.077)	(0.008)	(0.081)	(0.011)	(0.062)
Observations	2,195,841	123	1,007,204	123	775,218	123	413,419	122
R-squared	0.009	0.976	0.004	0.918	0.019	0.924	0.004	0.940
Basic control	NO	YES	NO	YES	NO	YES	NO	YES
Year fixed	NO	YES	NO	YES	NO	YES	NO	YES
State fixed	NO	YES	NO	YES	NO	YES	NO	YES

Note: Estimated with age, schooling in years, gender, marital status, experience, experience-squared, race, U.S. citizenship, for profit sector, and self-employment. Two stage regressions are weighted by the number of engineers. The second-stage estimates are aggregate state-level estimates of hours worked calculated from the predicted hours worked individual model, which are then aggregated to the state level. The ACS sample uses individuals who earn less than 250 USD per hour and who are college graduates. Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1.

Table B2: Effect of Pass Rates on Hours Worked using the Interaction (PE*Passrate)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	One level	Two level	One level	Two level	One level	Two level	One level	Two level
Sample	All	All	Civil	Civil	Electrical	Electrical	Industrial	Industrial
PE*Passrate	0.000***	-0.000	0.001***	0.000	-0.000***	-0.000	-0.000	
						0.001***		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
PE	-0.018***	0.016**	-0.061***	0.006	0.041***	0.005	-0.033***	0.023
	(0.002)	(0.007)	(0.002)	(0.010)	(0.002)	(0.015)	(0.003)	(0.014)
Passrate	0.000***	0.000	-0.000***	0.000	0.001***	0.000*	0.000*	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	3.750***	3.751***	3.773***	3.742***	3.709***	3.752***	3.775***	3.779***
	(0.001)	(0.006)	(0.002)	(0.008)	(0.002)	(0.013)	(0.003)	(0.012)
Observations	2,195,841	123	1,007,204	123	775,218	123	413,419	122
R-squared	0.002	0.950	0.004	0.952	0.003	0.882	0.003	0.915
Basic control	NO	YES	NO	YES	NO	YES	NO	YES
Year fixed	NO	YES	NO	YES	NO	YES	NO	YES
State fixed	NO	YES	NO	YES	NO	YES	NO	YES

Note: Estimated with age, schooling in years, gender, marital status, experience, experience-squared, race, U.S. citizenship, for profit sector, and self-employment. Two stage regressions are weighted by the number of engineers. The second-stage estimates are aggregate state-level estimates of hours worked calculated from the predicted hours worked individual model, which are then aggregated to the state level. The ACS sample uses individuals who earn less than 250 USD per hour and who are college graduates. Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1.

Table B3: Effect of Pass Rates on Hours Worked

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	One level	Two level	One level	Two level	One level	Two level	One level	Two level
Sample	All	All	Civil	Civil	Electrical	Electrical	Industrial	Industrial
PE	-0.055	0.116	0.020	0.224	-0.737***	-0.690***	0.592***	0.496***
	(0.038)	(0.096)	(0.054)	(0.158)	(0.080)	(0.159)	(0.075)	(0.151)
Pass rate	-0.006***	-0.006***	0.013***	0.014***	-0.017***	-0.018***	-0.037***	-0.039***
	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.003)	(0.002)	(0.003)
Observations	2,601,433	123	1,175,107	123	908,387	123	517,939	122
R-squared	0.038	0.962	0.051	0.946	0.045	0.953	0.038	0.967
Basic control	NO	YES	NO	YES	NO	YES	NO	YES
Year fixed	NO	YES	NO	YES	NO	YES	NO	YES
State fixed	NO	YES	NO	YES	NO	YES	NO	YES

Note: Estimated with age, schooling in years, gender, marital status, experience, experience-squared, race, U.S. citizenship, for profit sector, and self-employment. Two stage regressions are weighted by the number of engineers. The second-stage estimates are aggregate state-level estimates of hours worked calculated from the predicted hours worked individual model, which are then aggregated to the state level. The ACS sample uses individuals who earn less than 250 USD per hour and who are college graduates. Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1

Appendix C

Table C1: OLS Estimation of Effect of Liquidity Constraints (Round 2) on Children's Non-cognitive Skills in Later stage (Round 3) for Younger Cohort, including Liquidity Constraints in Round 3

VARIABLES (Round 3)	(1) Self-esteem	(2) Self-esteem	(3) Self-efficacy	(4) Self-efficacy
Liquidity Constraints				
Probably can raise in Round 2	-0.0262	-0.164**	-0.195**	-0.170*
	(0.0865)	(0.0701)	(0.0786)	(0.0943)
Cannot raise in Round 2	-0.131	-0.312*	-0.0491	-0.100
	(0.155)	(0.166)	(0.127)	(0.139)
Probably can raise in Round 3	-0.325***	-0.279***	-0.219**	-0.212**
	(0.0973)	(0.0911)	(0.0896)	(0.0899)
Cannot raise in Round 3	-0.562	-0.525***	-0.0708	0.00376
	(0.338)	(0.153)	(0.151)	(0.156)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	835	835	871	871
R-squared	0.088	0.269	0.060	0.135

Notes: 1. Self-esteem and self-efficacy are calculated by the average of answers of relevant questions. The summary indices are standardized. 2. Liquidity Constraints : "Can raise 300,000 VND (230,000 VND for Round 2)" is the omitted category. 3. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.

Table C2: OLS Estimation of Effect of Liquidity Constraints (Round 2) on Children's Non-cognitive Skills in Later stage (Round 3) for Older Cohort, including Liquidity Constraints in Round 3

VARIABLES	(1) Self-efficacy	(2) Self-efficacy	(3) Aspirations	(4) Aspirations
Liquidity Constraints				
Probably can raise in Round 2	0.0271	0.00733	0.234	0.325
	(0.0740)	(0.0848)	(0.227)	(0.242)
Cannot raise in Round 2	-0.172	-0.203	0.205	0.410
	(0.117)	(0.128)	(0.326)	(0.344)
Probably can raise in Round 3	-0.170*	-0.148	-0.0755	-0.0609
	(0.0920)	(0.0986)	(0.207)	(0.208)
Cannot raise in Round 3	-0.100	-0.108	-0.364	-0.539
	(0.228)	(0.261)	(0.347)	(0.367)
Individual Covariates	Y	Y	Y	Y
Community FE	N	Y	N	Y
Observations	674	674	809	809
R-squared	0.040	0.097	0.172	0.219

Notes: 1. Self-efficacy are calculated by the average of answers of relevant questions. The summary indices are standardized. 2. Liquidity Constraints : "Can raise 300,000 VND (230,000 VND for Round 2)" is the omitted category. 3. Standard errors clustered within village in parentheses. *** p<0.01.** p<0.05. * p<0.1.